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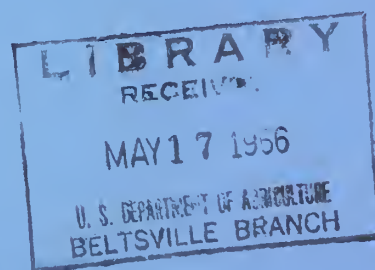
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ABSTRACTS

of recent published material on
Soil and Water Conservation

Number 37



ARS 41-75-13

Agricultural Research Service

UNITED STATES DEPARTMENT OF AGRICULTURE

The "ABSTRACTS of recent published material on Soil and Water Conservation" are issued at irregular intervals. Their purpose is to bring together a summary of current published information about soil and water conservation work. Reprints of abstracted articles are generally not available in the Soil and Water Conservation Research Division. Request for reprints should be sent to the authors or institutions, addresses are appended.

The classification of articles follows the table of contents used for the "Soil and Water Conservation Research Needs" of the Soil Conservation Service. Abstracted articles are not editorialized and the language of the author is used wherever possible. In foreign articles, the units of measure are converted to usual American units. Tables are included where they help to present the information. When the entire number of a publication is devoted to reviewing one subject then the entire publication is abstracted as one article giving title and authors of each paper included in the publication. Abbreviations of journals and addresses follow U.S.D.A. Misc. Publ. 765, July 1958.

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(16)	ARS-41-35	Aug.	1959
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(32)	ARS-41-75-8	Apr.	1965
(33)	ARS-41-75-9	Apr.	1965
(34)	ARS-41-75-10	May	1965
(35)	ARS-41-75-11	June	1965
(36)	ARS-41-75-12	Aug.	1965

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Charles B. Crook, Soil and Water Conservation Research Division,
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Plant Industry Station, Beltsville, Maryland, 20705

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WATERSHED ENGINEERING

Watershed Development

SEE ALSO 247.

1. Soil Conservation Service. ECONOMICS GUIDE FOR WATERSHED PROTECTION AND FLOOD PREVENTION. U.S. Dept. Agr., Soil Conserv. Serv. Unnumbered Rpt. irr. pp., March 1964.

This economics guide provides guidance in the use of acceptable economic evaluation procedures for evaluating watershed projects. These include projects developed under the authority of the Watershed Protection and Flood Prevention Act (P. L. 566 as amended), as well as the eleven authorized Flood Prevention watersheds.

The evaluation methods, procedures, and examples outlined were designed within the framework of existing statutory and policy requirements. Their use will tend to assure comparability of results and will facilitate review of watershed work plans.

Watersheds differ in physical and economic characteristics and also vary in the amount and kind of basic data available. No single procedure can be used in every watershed. Alternative procedures, that are consistent with the basic principles and concepts set forth in this Guide, may be used where necessary to better fit the varied conditions that are found throughout the United States.

Watershed Planning Div., SCS, USDA, Washington, D.C., 20250

Hydrology

SEE ALSO 12, 51, 148.

2. Water Committee. AN INVENTORY OF INFORMATION ON FEDERAL WATER RESEARCH ACTIVITIES AND FACILITIES. Denver Fed. Exec. Board (Unnumbered) \$2.10, May 1964.

General information was provided about Federal water research activities in western United States being carried on by the Agriculture Research Service and Forest Service of the U.S. Department of Agriculture; the Public Health Service of the U.S. Department of Health, Education, and Welfare; and the Bureau of Reclamation and Geological Survey of the U.S. Department of the Interior. The information given includes the project title, location, objective of research, project leader and key personnel, official name of facilities, functional purpose and/or capability of facilities, location, and type of and/or description of unusual or special purpose equipment. The specific areas of research are in the general categories of hydraulics, hydrology, agriculture, biology, irrigation, ecology, economics, chemistry, physics, nuclear physics, meteorology, civil engineering, soils, geology, drainage, electric power, botany, soil and water conservation and management, forestry, and fish and wildlife. The geographical area in which the research is being conducted is in Arizona, Colorado, Idaho, Kansas, Montana, Nebraska, New Mexico, South Dakota, Utah, and Wyoming.

Water Committee, Denver Fed. Exec. Board, Denver, Colo.

3. Bear, J., and Dagan, G. MOVING INTERFACE IN COASTAL AQUIFERS. J. Hydraul. Div., ASCE 90 (HY 4): 193-216. 1964.

The movement of the interface between fresh water and sea water in coastal aquifers caused by changes in seaward flow of fresh water was considered. Approximate solutions to the moving interface, its shape, position, and velocity of displacement were suggested. The following assumptions were made: (1) The aquifer is confined and the flow pattern is

two-dimensional; (2) the aquifer is homogeneous and isotropic; and (3) the fresh water and sea water are immiscible.

Assuming that the aquifer was relatively thin, the Dupuit assumption was applied to the flows in both the fresh water region above the interface and the salt water region below it. The average specific discharges obtained in this way were then combined with the continuity equation to yield partial differential equations for the time-variable thickness of the fresh water flow region. In order to solve these equations, certain assumptions regarding the variation of fresh water flow above the interface had to be made. The solutions derived were compared with experimental results obtained from a Hele Shaw model. Graphs and numerical examples were presented. The approximate solutions described the interface movement with sufficient accuracy for practical purposes.

Technion-Israel Inst. of Tech., Haifa, Israel.

4. Shanholtz, V. O., and Dickerson, W. H. INFLUENCE OF SELECTED RAINFALL CHARACTERISTICS ON RUNOFF VOLUME. W. Va. Agr. Expt. Sta. B. 497T, 27 pp. 1964.

The influence of selected rainfall characteristics on surface runoff volume was investigated to bring together rainfall characteristics which may influence the runoff regimen. A numerical value was established for each and their relative influence was determined by linear and multiple regression analyses. Data were obtained from the Coshocton, Ohio, and Moorefield, W. Va., ARS Research Stations.

The parameters studied included total rainfall, intensity, distribution, pattern, energy, duration, and interaction terms. Total rainfall gave the best single estimate of runoff volume. The energy of the storm raindrops as defined by Wischmeier, et al. (1958) estimated runoff with about the same accuracy as total rainfall. A very high intercorrelation ($r = 0.99$) existed between energy and total rainfall.

The 60-minute maximum intensity period (I_{60}) for both the Moorefield and Coshocton data was found to give the best average estimate of runoff of all the intensity periods studied. An r^2 of 68 percent and 30 percent was noted for the Coshocton and Moorefield data, respectively. The intensity-amount-distribution index (SL) indicated no workable correlation with runoff volume. The pattern index (PI) indicated no workable relationship for either the Coshocton or Moorefield data. A weighted pattern index (PI_{wt}), which tended to dampen the influence of periods of low intensity, showed considerable improvement over the pattern index, resulting in an increase in r^2 from 6.4 percent to 21.7 percent for the Coshocton data. The only visible change in the Moorefield data was a change in sign of the correlation coefficient. The storm duration parameter (D) showed statistical significance at the 1 percent level, but this was due primarily to the intercorrelation between total rainfall and length of storm.

Product terms involving storm duration and maximum intensity contributed more information than the individual parameters. The $I_{60}.D$ factor accounted for 72 percent of the runoff volume sums of squares. Of the numerous interaction terms involving the PI and SL parameters, only two, $SL.I_{60}$ and $PI.I_{60}$, indicate possible importance.

The analysis of rainfall characteristics indicated that no single rainfall characteristic could be used to satisfactorily estimate runoff volume. Errors of 20 to 25 percent would result from the Coshocton sample, whereas errors of 50 percent or greater could be expected from the Moorefield sample. The intensity, amount, distribution, pattern, and energy of a given storm influenced the magnitude of the resulting runoff. These characteristics could be represented by numerical values.

Watershed conditions play a major role in conjunction with rainfall characteristics in producing runoff from any given storm event. By including appropriate parameters to reflect the influence of these interrelations in the rainfall-runoff equation, the error could possibly be reduced significantly.

Tables and graphs.

Agr. Engr. Dept., Va. Polytechnic Inst., Blacksburg, Va., 24061

5. Helvey, J. D. RAINFALL INTERCEPTION BY HARDWOOD FOREST LITTER IN THE SOUTHERN APPALACHIANS. U.S. Forest Ser. Res. Paper SE-8, 8 pp. 1964.

Moisture interception by hardwood litter was studied by improved methods at the Coweeta Hydrologic Laboratory near Franklin, N.C., during 1961-62. Maximum field water content of hardwood litter averaged 215 percent of oven-dry weight. Average minimum moisture content, reached after 12 rainless days, was about 40 percent by weight. One inch of throughfall was required to raise litter moisture from 40 percent to 215 percent. Interception loss from hardwood litter during 1962 was about 2.2 inches; the long term average was an estimated 3 inches per year.

Southeastern Forest Expt. Sta., FS, USDA, Asheville, N.C.

6. Reinhart, K. G. APPROXIMATING SOIL-MOISTURE STORAGE IN EXPERIMENTAL WATERSHEDS BY MEANS OF PRECIPITATION AND STREAMFLOW RECORDS. Soil Sci. Soc. Amer. Proc. 28(4): 575-578. 1964.

An estimate of total soil-moisture storage capacity of an experimental watershed is needed to understand its hydrology. A reliable estimate may be very difficult to obtain, particularly in a forested watershed, because of variations in and difficulties of measuring soil depth, root depth, texture, bulk density, stone content, and moisture content. A method was suggested for approximating storage from precipitation and streamflow records. Precipitation minus runoff—in selected periods when ample precipitation follows a dry spell—provided the estimate of soil-moisture storage capacity. The method was illustrated with data from the Fernow Experimental Forest in West Virginia and was applied to two other watersheds in the Northeast. Limitations of the method were discussed.

Northeastern Forest Expt. Sta., FS, USDA, Parsons, W. Va.

7. McGuinness, J. L., and Urban, J. B. SOIL MOISTURE SAMPLING PLAN FOR WATERSHEDS. U.S. Dept. Agr., Agr. Res. Serv. ARS 41-87, 12 pp. 1964.

The general concepts of sampling theory as they apply to soil moisture measurements in hydrology were given. Frequent random selection of sampling sites in a watershed is usually not practical. As a rule, the procedure is to choose fixed sites, install instruments, and read them periodically. Furthermore, soil moisture evaluations need to be related to soil profile characteristics. In fact, the hydrologist must know the surface and subsurface characteristics of the watershed and have a clear idea of the objectives of the soil moisture program before the statistical layout can be planned.

The purpose for which the sampling is made will influence the intensity of sampling. If the main purpose of the sampling is to estimate the "true" average moisture content of the soil to some specified depth, samples may be required at numerous points in the watershed. If only a rough index of watershed moisture is needed, fewer sampling sites may be required.

A guide for designing a soil moisture sampling plan for any specific watershed area, based on an example from the Coshocton Station, was described.

ARS, USDA, Inform. Div., Room 645A, FCB, Hyattsville, Md., 20781

8. Horton, J. S., Robinson, T. W., and McDonald, H. R. GUIDE FOR SURVEYING PHREATOPHYTE VEGETATION. U.S. Dept. Agr. Handbook 266, 37 pp. 1964.

Phreatophyte vegetation seriously affects water supplies in arid and semiarid regions. Knowledge of the extent and nature of the vegetation cover is needed as a basis for planning treatments of the vegetation and estimating the potential water savings and other effects. Surveys of the vegetation require an economical sampling scheme that can be repeated and will yield data that are precise enough to be reliable. Such a scheme was described and the following seven steps necessary in a proper survey were explained: (1) Assemble aerial photographs and become familiar with the survey area and its important species; (2) map vegetation types on the aerial photographs and refine the type boundaries by observation from aircraft; (3) determine number of sampling lines; (4) develop a random-sampling system; (5) collect field data from the randomly selected points or lines, to be permanently marked; (6) determine the reliability of the field data; and (7) summarize the data.

Possible variations in the scheme that can be used when the standard method is not completely adaptable were presented, and their applicability in the various phreatophyte types was stated.

Tables and photographs.

FS, USDA, Inform. Div., Washington, D.C., 20250

Geology

SEE ALSO 2, 6, 18, 19, 23, 24, 43, 45, 134, 265.

9. Nordin, C. F., Jr. STUDY OF CHANNEL EROSION AND SEDIMENT TRANSPORT. J. Hydraul. Div., ASCE 90 (HY 4): 173-197. 1964.

Observations of channel erosion, flow, and sediment transport for the Rio Puerco, in New Mexico, indicated that the characteristics of the channel and of the channel material changed rapidly because of deposition and erosion, and that the ephemeral flows carried extremely high concentrations of suspended sediment that influenced flow and transport characteristics.

U.S. Geol. Survey, Dept. Int., Fort Collins, Colo.

10. Guy, H. P. SEDIMENT TRANSPORT IN ALLUVIAL CHANNELS: AN ANALYSIS OF SOME STORM-PERIOD VARIABLES AFFECTING STREAM SEDIMENT TRANSPORT. U.S. Dept. Int., Geol. Survey Prof. P 462-E, 46 pp. 1964.

A review of the theory of sediment yield and transport indicates that for most streams, the bulk of the suspended sediment transport occurs during the relatively brief storm periods when the drainage basin collects and routes precipitation excess to a specific site. Therefore, a description of the quantity of sediment moved during the storm runoff periods at a stream location must be based principally on the active and passive forces of erosion.

The investigation of these forces was accomplished by using a combination of graphical and analytical multiple correlation techniques. Graphical correlation was employed on data for seven stream locations in the Atlantic coast area; (1) To determine which climatic, hydrologic, and sedimentologic variables might be used; (2) to determine the required transformation of data; and (3) to note any unusual elements of data or wild points for specific variables. An analytical method using the general multiple regression model on the electronic computer was employed to develop and indicate the accuracy of optimum equations for predicting sediment movement with

surface runoff. Several combinations of variables for each stream location were used to show the effect of interdependence among the variables.

In regard to a choice of the dependent variable for defining sediment variation, the mean concentration of sediment in streamflow was found to be somewhat superior to sediment discharge due to the high degree of intercorrelation between water discharge and sediment discharge.

Some of the storm-to-storm variation of sediment concentration in streamflow was associated with storm magnitude, the time during a period of record, the season of the year, the antecedent condition of the basin, and the storm intensity. The sediment moving in streams tended to increase intensity. The sediment moving in streams tended to increase with measures of storm magnitude such as surface runoff quantity or rainfall quantity. An apparent trend of decreasing sediment with time was indicated for all seven locations, but was statistically significant only for the locations on the Brandywine Creek and the James River basins. With respect to seasonal change, sediment concentration tended to increase as mean air temperature increased. With respect to antecedent condition, sediment concentration tended to decrease as ground water runoff increased. Ground water runoff was generally high during the cool season for the Atlantic coast area; therefore, intercorrelation with mean air temperature reduces the importance of this variable. Sediment concentration increased with storm intensity. The measures of storm intensity used were peakedness index, peak flow, and rainfall intensity; however, only peakedness index was tested for all streams.

The standard error of estimate of the dependent variable (the storm-period sediment concentration) ranged from 0.14 to 0.30 log units for most combinations of the independent or causative variables mentioned above. The range of this error was greater among the different streams than among the different combinations of variables for a given stream.

Three of the regression formulas derived were tested for extrapolation to other areas using observed data from the Shenandoah and Potomac Rivers. The results showed that these formulas can and must be modified to give a satisfactory comparison with the observed data.

Supt. Doc., U.S. Govt. Print. Off., Washington, D.C., 20402

11. Fowler, L. C. GROUND-WATER MANAGEMENT FOR THE NATION'S FUTURE—GROUND-WATER BASIN OPERATION. J. Hydraul. Div., ASCE 90 (HY 4): 51-57. 1964.

Total usable water supply can be increased by coordinated operation of surface and underground water resources. Under optimum coordinated operation, the unit cost of water supply storage and distribution can be a minimum. Efficiency in managing ground water basins to bring about coordinated operation requires new concepts to be evolved and to be effectively applied.

The basic principles of ground water basin operation that will result in an optimum water resources management scheme for an area were summarized as follows:

1. The surface and underground storage capacities must be integrated to obtain the most economical utilization of the local storage resources and the optimum amount of water conservation.
2. The surface pipeline system must be integrated with the ground water basin transmission characteristics to provide the minimum cost distribution system.
3. An operating agency must be available with adequate powers to control or cooperate in the control of the surface water supplies, ground water recharge sites, surface water delivery facilities, and amount and location of ground water extractions.

Santa Clara County Flood Control and Water Conserv. Dist., San Jose, Calif.

12. Tyson, H. N., Jr., and Weber, E. M. GROUND-WATER MANAGEMENT FOR THE NATION'S FUTURE—COMPUTER SIMULATION OF GROUND-WATER BASINS. J. Hydraul. Div., ASCE 90 (HY 4): 59-77. 1964.

A mathematical model of a ground water basin, representing its storage and transmissive characteristics, was developed and tested using general purpose analog and digital computers. The model permitted water level elevations within the basin to be predicted, particularly in response to extraction and recharge activities carried out under a program of planned use and basin management. Large amounts of geologic and hydrologic data were collected, analyzed, and reduced for use in the computer simulation. A suitably simplified model of an aquifer system was developed that led to the diffusion equation in two dimensions. This diffusion model was approximated by a system of difference-differential equations defined by a set of asymmetrically-spaced node points. The procedure developed for ground water basin analysis was extended to handle certain nonlinear features.

Advisory Systems Engin., Data Processing Div., IBM Corp., Los Angeles, Calif.

13. Chun, R. Y. D., Mitchell, L. R., and Mido, K. W. GROUND-WATER MANAGEMENT FOR THE NATION'S FUTURE—OPTIMUM CONJUNCTIVE OPERATION OF GROUND-WATER BASINS. J. Hydraul. Div., ASCE 90 (HY 4): 79-95. 1964.

A general purpose method to determine the most economical coordinated operation of surface and underground water supplies and facilities was developed. This method enables the engineer to integrate surface and ground water usage in operational and economic evaluation of alternative plans of operation, and allows determination of most economic combined use of facilities.

The method requires a large number of computations, even for an analysis of a single plan of operation. In order to evaluate the physical and economic effects of a large number of physically possible alternative operational plans, it was necessary to make extensive use of electronic computers.

It was believed that partial or total application of the method will provide much of the data necessary for making current management decisions relative to the manner of best meeting future water requirements within the study area. Not only can a few arbitrarily selected operational plans be compared relative to themselves, but a means was provided whereby the optimum plan could be described. Other plans, based on compromise or expediency, could then be analyzed and compared with the derived optimum.

Written in general terms, and preserved in the computer program statements, the method also allows for rapid updating and adjustment of operating criteria as experience is gained in the actual operation of a selected plan. The cost and hydraulic information gained will provide management an insight for solution of the administrative and legal problems that may accompany any operational plan.

Calif. Dept. Water Resources, Los Angeles, Calif.

14. Valantine, V. E. GROUND-WATER MANAGEMENT FOR THE NATION'S FUTURE—EFFECTING OPTIMUM GROUND-WATER BASIN MANAGEMENT. J. Hydraul. Div., ASCE 90 (HY 4): 97-105. 1964.

The most economical plan for coordinating the construction and operation of surface and ground water basin systems must be developed with the assumption that any legal obstacles may be overcome and that the necessary management organization will be available. In implementing an optimum plan, however, the problems imposed by these assumptions must be resolved. The legal and management limitations imposed by existing rights to extract ground waters, and the fragmentation of the water service to lands

overlying a ground water basin by many producing and distributing agencies and by existing water supply systems were examined. Procedures for overcoming these limitations and achieving the unified and coordinated operation of ground water surface water systems were investigated, and a recommended solution was presented.

Resource Agency Calif., Dept. Water Resources, Los Angeles, Calif.

Engineering Design

SEE ALSO 2, 12, 13, 22, 40, 42.

15. Watters, G. Z., and Street, R. L. TWO-DIMENSIONAL FLOW OVER SILLS IN OPEN CHANNELS. J. Hydraul. Div., ASCE 90 (HY 4): 107-140. 1964.

An ideal fluid was used to approximate the two-dimensional flow of a real fluid over sills in an open channel. The computation of the location of the free surface, the velocity, and the pressure at any point in the flow was made possible by a general theory that used complex function theory and conformal mapping. The general theory was derived by considering flow over a simple, vertical step in an open channel. The theory was expanded to include flow over polygonal sills, flow over smooth sills, and through smooth transitions. Numerical examples were given for particular flow configurations.

Utah State U., Logan, Utah.

16. Vallentine, H. R. CHARACTERISTICS OF THE BACKWATER CURVE. J. Hydraul. Div., ASCE 90 (HY 4): 39-49. 1964.

The profiles of over forty M1 curves in rectangular channels were examined. The ranges of variables covered were: n , from 0.012 to 0.050; breadth-to-depth ratio, 2, 10, and infinity; and bed slope, 10^{-3} to 10^{-6} . The effects of variation of n and S_0 (channel bed gradient) on the profile form were examined. Nondimensional plots of profiles for given channel geometries were found to rank according to normal flow Froude numbers (F_0). The maximum surface displacement and the profile length, expressed in nondimensional form, were found to be functions of F_0 .

U. New South Wales, Manly Vale, New South Wales, Australia.

17. McGuinness, J. L., and Brakensiek, D. L. SIMPLIFIED TECHNIQUES FOR FITTING FREQUENCY DISTRIBUTIONS TO HYDROLOGIC DATA. U.S. Dept. Agr. Handbook No. 259, 42 pp. 1964.

Simplified procedures for fitting the most commonly used distributions in hydrologic frequency analysis—the normal, extreme-value, log-normal, and modified log-normal distributions were given. The modified log-normal distribution is well suited for the case where a specific statistical distribution is not or cannot be postulated. In addition to fitting procedures, a simple test of the hydrologic representativeness of a set of hydrologic data was outlined.

The question of the appropriate formula to use in computing the frequency plotting positions for data is one illustration of the disagreement that generally exists. The authors prefer the formula $\frac{m}{(n+1)}$, where m is the order number of the point and n is the number of points to be fitted. This formula was derived by Gumbel (1941) and Chow (1953) and is distribution-free. Yet an earlier formula developed empirically by Hazen (1930), $\frac{m}{(2n-1)}$ is favored by some workers.

There has also been some debate in the past as to whether only the maximum of annual values or all values above a certain base value should be selected for a frequency analysis. Chow (1951) has shown that for recurrence intervals of about 10 years or longer there is essentially no difference between the two methods of selecting data. Since the series of maximum values is simpler and theoretically more suited for frequency analysis, the authors prefer it to the partial-duration series. The hydrologist using frequency distributions to describe his data should recognize the inherent limitations of the method. The data constitute a sample only. Samples, particularly small samples, are noted for the way in which they may vary from their parent populations. To obtain the true 50-year peak rate estimate for a watershed with 20 years of record, it would be necessary to show: (1) That the 20-year record is completely representative of the long-term (but unknown) peak rate statistical distribution; and (2) that the statistical distribution used to describe the 20-year record is the true distribution that exactly describes the long-term (unknown) peak rate frequency distribution for the watershed under study.

The hydrologist may take steps (described) to provide a satisfactory answer to the first of these requirements. The second must rest on assumptions that generally cannot be proved. Despite the limitation, however, frequency analyses are a valuable tool in hydrologic studies of small areas.

ARS, USDA, Inform. Div., Room 645A, FCB, Hyattsville, Md., 20781

18. Reinhart, K. G., and Pierce, R. S. STREAM-GAGING STATIONS FOR RESEARCH ON SMALL WATERSHEDS. U.S. Dept. Agr. Handbook 268, 37 pp. 1964.

With an increasing population and percapita consumption of water, nationwide concern has arisen about the adequacy of our water supplies. Some regions suffer acute shortages. Yet many areas sustain major damage from great floods.

Watershed research has shown that land use and treatment affect both water yield and peak flows. Under certain situations, yield may be increased by vegetation management and other land practices; in other circumstances, peak flows may be reduced.

One of the accepted research techniques in watershed management is the measurement of streamflow from small experimental watersheds. Such measurement permits evaluation of the effect that manipulation of cover has on water-yield characteristics for fairly homogeneous areas.

A general guide on the design and construction of small stream-gaging stations was given.

The types of gaging stations with which the authors have had personal experience were discussed in detail. Other types of stations were considered in a more general way to provide an overall treatment of the subject.

Photographs, charts, and tables.

FS, USDA, Inform. Div., Washington, D.C., 20250

19. Ackers, P. EXPERIMENTS ON SMALL STREAMS IN ALLUVIUM. J. Hydraul. Div., ASCE 90(HY 4): 1-37. 1964.

An experimental study of small streams in alluvium indicated correlations between stream geometry and discharge. These were compared with established regime equations, with some areas of disagreement. Results were analyzed on the basis of sediment transport, channel roughness, and width-depth ratio. These three physical relationships could be used to predict the geometrical functions.

Dept. Sci. and Indus. Res., Hydrol. Res. Sta., Wallingford, Berkshire, England.

WATER MANAGEMENT

Irrigation

SEE ALSO 2, 43, 51, 61, 66, 98, 106, 132, 133, 135, 143, 151, 152.

20. Bourns, C. T. WANT TO GET TWICE AS MUCH WATER FROM THE SAME SOURCE? Nev. Ranch and Home Rev. 2(6): 14-15. 1964.

Nevada's agricultural water supply can be doubled by the use of improved technology and management.

More than 90 percent of the water diverted in the West is for irrigated agriculture. Most of the wastes or water inefficiencies are found in irrigation.

The U.S. Bureau of Reclamation recently reported that the average losses from canal systems under their control was 37 percent. This loss only leaves 63 percent of the original water for the farmer. Seepage losses from ditches on pump-irrigated farms revealed losses as great as 47.8 percent per 1,000 feet of ditch on a fine sandy loam soil to a low of 1.7 percent per 1,000 feet of ditch on a very heavy clay loam. Delineation of canal and ditch sections which are conducive to high seepage and subsequently sealing or lining them would reduce this loss significantly. The elimination of riparian vegetation along canals and the storage of water would also minimize losses in storage and conveyance.

The major losses of irrigation water occur on the farm. A survey of on-farm water application efficiency trials revealed that most seasonal efficiencies were about 20 percent. There were isolated seasonal and individual instances, of efficiencies running as high as 78.7 percent. "On-farm" or "application" efficiencies of 65 percent or better are not difficult to attain with a combination of properly designed irrigation systems and good water management by the individual irrigator.

Inefficient water use is responsible for losses other than from the water itself. "Tailwater" runoff and deep percolation remove valuable plant nutrients and soil. Crop yields are depressed through lack of proper soil aeration and by high water tables. The root-zone of the soil is raised in salinity, which depresses yields and makes for even poorer soil structure. Health, water pollution, and mosquito control problems are created.

Max C. Fleischmann C. Agr., U. Nev., Reno, Nev.

21. Keller, J. LESS SOIL COMPACTION WITH LOW APPLICATION RATE SPRINKLING. Sprinkler Irrig. Assoc. Open Tech. Conf. Proc. 1964: 45-50. 1964.

A laboratory study on the effects of sprinkler application rate on soil structure was reported that explains the improved soil tilth and resulting increased production that have been observed under low application rate sprinkler irrigation. The study may lead to development of a laboratory procedure for determining what constitutes an ideal application rate for a given soil.

The effect of sprinkler application rate on soil structure during sprinkling was studied on a silt loam, a silty clay loam, and a clay loam soil.

For all soils studied, a critical application rate existed for a given soil and boundary condition. The critical application rate was defined as the application rate below which the soils do not settle during sprinkling, and above which they do settle.

The laboratory evidence could lead to the development of sprinkler irrigation practices that will: Improve seed germination; reduce cultivation needs; increase soil aggregation; and permit the reclamation of easily dispersed soils.

Certain sodic soils of poor structure tend to become so dispersed when saturated that they are practically impermeable to air and water. Some of these soils have been reclaimed by low application rate sprinkler irrigation. The reclamation process was achieved by sprinkling at an application rate sufficiently low to assure that the soils did not disperse and settle during watering. The application rate which does not result in saturation high enough to cause particle dispersion and soil settlement may actually be greater than the infiltration rate of the ponded soil. Under low application rate sprinkler irrigation, the soils can be used for agricultural production, the sodic ions replaced by more stable ions, and the organic content increased, with the result that a rather stable aggregate can be achieved. Once the soil aggregate becomes more stable, the application rate may be increased without detrimental effect.

Utah State U., Logan, Utah.

22. Thornton, J. F., and Beasley, R. P. CHARACTERISTICS OF FLOW IN TRAPEZOIDAL AND TRIANGULAR IRRIGATION FURROWS. Mo. Agr. Expt. Sta. Res. B. 855, 36 pp. 1964.

The characteristics of flow in irrigation furrows, as influenced by furrow shape, roughness, slope, and rate of flow were investigated.

Hydraulic tests were conducted in a flume 30 feet long, 3.33 feet wide, and 1.66 feet deep. Furrows with trapezoidal and triangular shapes were formed in the flume.

Tests were run on four different roughnesses, using five rates of flow and six slopes. The furrows were constructed of aluminum and lined with silt or sand to provide different degrees of roughness. Additional tests were run using furrows of the above-mentioned shapes formed in soil. During one series of tests, water was removed from the soil by a vacuum system to maintain infiltration. Another series was run without infiltration. Tests on furrows in soil were also run with five rates of flow and six slopes.

Data from the hydraulic tests were analyzed to determine the relationship between the roughness coefficient and the following variables: (1) The velocity; (2) the depth; (3) the hydraulic radius; and (4) the Reynolds number. These results were presented graphically.

Results of the investigation indicated that:

1. The roughness coefficient was a function of the velocity, depth, hydraulic radius, and Reynolds number. The roughness coefficient decreased with an increase in each of these four variables.
2. The roughness coefficient was higher for the trapezoidal furrow than for the triangular furrow with the same rate of flow, degree of roughness, and slope.
3. The Reynolds number was three to eight times higher for the triangular furrow than for the trapezoidal furrow with the same rate of flow, degree of roughness, and slope.
4. The average infiltration rate was 0.12 inch per hour for the trapezoidal furrow and 0.87 inch per hour for the triangular furrow.

Coastal Plains Soil & Water Res. Center, Florence, S.C., 29501

23. Wilson, T. V., Snell, A. W. SHALLOW GROUNDWATER FOR IRRIGATION. Clemson U. Agr. Res. 10(1): 15. 1964.

Shallow ground water can be obtained by excavating a pit, or by installing shallow well points, each of which should extend to a depth below the water table in order to intercept "free" water in the soil.

Pits have been used widely for irrigation water. Water available for irrigation from a pit depends upon its storage volume below the water table plus the rate of recharge from ground water. Sometimes pits are located in places where they receive surface runoff, raising the pit water level above the surrounding water table.

An ideal location for a dug pit is one where: (1) Permeability of the water-bearing sand is high; (2) the water table slopes toward the site; and (3) very little normal water table fluctuation occurs throughout the year.

Shallow wells will also supply water for small acreages of irrigated crops. Research was conducted on wells ranging from 22 to 43 feet in depth. Screens 2.5 inches in diameter, 8 and 16 feet long, were used. Screen mesh was selected to permit some "natural developing"—a process of washing out some of the fine sand surrounding the screen to increase the rate of flow into the well.

To permit use of an irrigation system which pumps approximately 350 gallons per minute, a 350,000 gallon plastic-lined reservoir was made near the pumping station. This reservoir held enough water to supply one irrigation for 6 acres of tobacco. Approximately 3.5 days pumping from the wells was required to fill the reservoir. Individual wells yielded maximum rates of 20 to 35 gallons per minute. The maximum obtained from the four-well battery was approximately 80 gallons per minute.

After pumping was stopped, the water table in the immediate vicinity of the wells recovered to within 1.5 feet of the original level within 2 days.

There are advantages and disadvantages of both pits and wells. Both are usually limited to small acreage irrigation. Pits have the advantage of storing water. The total water available is the sum of that stored in the pit plus recharge from ground water. Wells depend entirely on rate of water entry into them, but they have the advantage of reaching a greater depth of ground water. Water can be pumped from depths of about 25 feet below the ground surface with suction-lift pumps. The practical limitation on depth of pits is 15-20 feet. Other advantages of wells are: (1) They can be located more conveniently to the area of use; (2) there are no spoil banks which present maintenance problems; and (3) they do not take land out of production. The principle advantage of pits is the storage of water which can be pumped at any rate.

S.C. Agr. Expt. Sta., Clemson Col., Clemson, S.C.

24. Rollins, M. B. WHAT IS THE QUALITY OF YOUR IRRIGATION WATER? Nev. Ranch and Home Rev. 2(8): 6-7. 1964.

During 1959-62, a cooperative study was made of the irrigation and drainage water quality of the Newlands Project surrounding Fallon, Nev.

Water samples were taken throughout the project in both canals and drains to determine just what happened to water in terms of quality, and to give users standards to go by. Sampling stations were located so that water quality could be traced downstream. Samples were taken each consecutive month so that water quality could be followed through seasons of the year.

Irrigation waters of the Newlands Project were generally of good quality. According to current USDA classification, the irrigation water, when drainage water was absent, had a medium salinity hazard and practically no sodium hazard. But the quality was substantially degraded when drainage waters containing large amounts of salts were diverted into the canals for irrigation reuse, a common practice in this irrigation project.

Drainage waters contained larger amounts of total salts with a higher percentage of sodium than irrigation waters. Drainage waters varied from a medium salinity and low sodium hazard to a very high salinity and very high sodium hazard.

The salinity of irrigation water increased slightly each year as the irrigation season progressed, then decreased as large volumes of low-salt spring runoff replenished the reservoir supply.

At the termination of the irrigation season, the drainage waters increased sharply in total salts and continued to increase through the winter until irrigation was started again in the spring. For this reason, most drainage waters should not be placed upon good land during the winter.

The management of irrigation water by itself is not difficult. With a moderate amount of leaching for irrigated lands, there is little danger of salt buildup with this water. But the use of drainage water for irrigation may require special attention to avoid saline or sodic problems from developing.

Southwest Br., SWCRD, ARS, USDA, Reno, Nev., 89507

25. Korven, H. C., and Wilcox, J. C. EFFECTS OF FLOW VARIATIONS ON THE SALT CONTENT AND REACTION OF A MOUNTAIN CREEK. *Canad. J. Soil Sci.* 44(3): 352-359. 1964.

Water samples were taken and the stream flow measured at intervals during the summer of 1962 at several locations on a mountain stream and its tributaries which are a source of water for domestic and irrigation purposes for Summerland, B.C. Electrical conductivity and pH were determined for each sample and related to flow.

There were highly significant negative correlations between the amount of water flowing past any given point in a stream and both conductivity and pH of the water at that point. Conductivity and pH showed high positive correlations. Considering the main stream on any one date, there was a increase in salt content of the water with a decrease in elevation. Storage reservoirs were beneficial because during the major portion of the irrigation season when storage water was being used, the increased flow meant a water supply of lower salt content and alkalinity than would be the case under normal stream flow.

Expt. Farm, Canada Dept. Agr., Swift Current, Saskatchewan, Canada.

26. Bruns, V. F., and Yeo, R. R. TOLERANCE OF CERTAIN CROPS TO SEVERAL AQUATIC HERBICIDES IN IRRIGATION WATER. U.S. Dept. Agr., Agr. Res. Serv. Tech. B. 1299, 22 pp. 1964.

A preliminary greenhouse study on the tolerance of beans and corn to aromatic solvent No. 1 was conducted at Prosser, Wash., in 1958. Field experiments were conducted each year at one or more of the following locations during 1958-61: Prosser, Wash.; Huntley, Mont.; and Phoenix, Ariz.

In Washington, young corn and beans in the greenhouse were injured slightly when the soil was wetted to field capacity with 270 to 3,000 p.p.m.v. of aromatic solvent No. 1 in irrigation water. In the field experiments, solvent applications at 740 to 2,960 p.p.m.v. (one to four times the concentration necessary for control of submersed aquatic weeds in irrigation canals) did not reduce per-acre yields of corn or field beans.

In Washington, acrolein at 20 p.p.m.v. killed 3 percent of the soybean plants and slightly or moderately injured the others. Corn, however, was injured only slightly. Yields of neither crop were reduced. Acrolein at 60 and 150 p.p.m.v. severely injured the soybeans and significantly reduced the stands and yields. At 150 p.p.m.v., corn was injured severely and 3 percent of the plants were killed, but yields per acre were not reduced.

In Montana, acrolein at 180 p.p.m.v. or fewer did not reduce the yield of sugar beets or silage corn. At 60, 120, and 180 p.p.m.v., field beans were injured in 1958, and the yields were reduced. At 60 p.p.m.v. or fewer, bean yields were not reduced in 1959. No acrolein residues were found in vegetative samples of beets, corn, or beans collected at harvest in 1958.

In Arizona, acrolein at 100 p.p.m.v. or fewer did not injure cotton appreciably nor reduce yields significantly when applied at the first or at the first and third flood irrigations. Concentrations of 160 p.p.m.v. or higher, however, severely injured the plants and significantly reduced the yields. In comparison with tests in Washington and Montana, flood-irrigated cotton was less tolerant to acrolein than furrow-irrigated corn or sugar beets but was considerably more tolerant than furrow-irrigated soybeans or field beans.

Quaternary ammonium compounds No. 1 and No. 3, particularly at 350 p.p.m.v., somewhat reduced the vigor but not the yield of corn in Washington. Compound No. 1 at 150 and 350 p.p.m.v. killed a few soybeans and suppressed somewhat the growth of the others, but it did not reduce per-acre yields. Compound No. 3 appeared less injurious than compound No. 1. Diquat at 125 p.p.m.w. or fewer did not visibly affect the foliage of corn. The growth of field beans, however, was noticeably suppressed by diquat even at 5 p.p.m.w. The incidence of root rot and mites interfered with the evaluation of yield differences.

Disodium salt of endothal at 25 p.p.m.w. or fewer did not visibly injure corn. Field beans were severely injured and yields were reduced by even 1 p.p.m.w.

Tables and photographs.

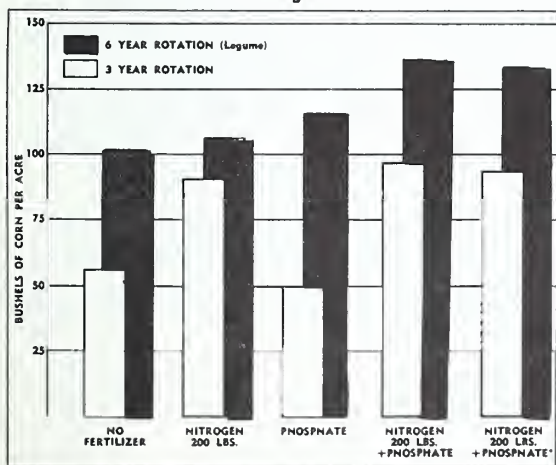
ARS, USDA, Inform. Div., Room 645A, FCB, Hyattsville, Md., 20781

27. Robinson, C. W., and Schumaker, G. BIG YIELDS MADE ON "PROBLEM" SOILS. Colo. Rancher and Farmer 18(10): 5-6. 1964.

Results of cooperative research being conducted in the lower Grand Valley west of Grand Junction, are pointing the way to increased production of field crops on the fine-textured problem soils of the area. These irrigated soils are often plagued with problems of: poor drainage; excessive salt and sodium accumulation; crusting; poor water intake; and erosion.

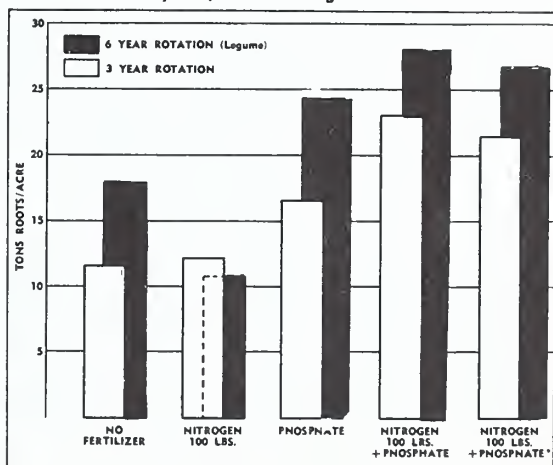
To find out how to overcome these problems and obtain higher crop yields, rotation and fertilizer research was begun on these soils in 1954. A pump installed in 1951 effectively lowered the high water table to solve the poor drainage. The rotation and fertilizer work studied the relative desirability of a short-term rotation of corn, sugar beets, and barley in contrast to a long-term rotation which included these same crops and 3 years of alfalfa. The merits of continuous cropping of cultivated crops, corn and sugar beets, were also studied.

Figure 1.—Effect of rotation and fertilizer on corn yield, 1958 through 1961.



*Phosphate application on barley crop 4 years prior to corn crop

Figure 2.—Effect of rotation and fertilization on sugar beet yields, 1959 through 1961.



*Phosphate application on barley crop 5 years prior to beet crop

After 2 years of a uniform crop of corn, the effect of alfalfa in the rotation was still very much in evidence with yields of 130 bushels per acre on the 6-year rotation and yields of 58 bushels on the 3-year rotation.

Colo. Agr. Expt. Sta., Ft. Collins, Colo.

28. Letey, J., Stolzy, L. H., and Morgan, W. COMPACTED GOLF GREENS RESPOND TO DEEP AERATION, CONTROLLED IRRIGATION: LOS ANGELES COUNTY TESTS. Calif. Agr. 18(6): 8. 1964.
29. Dorman, F. W., and Hemstreet, C. L. COMPACTED GOLF GREENS RESPOND TO DEEP AERATION, CONTROLLED IRRIGATION: SAN BERNARDINO COUNTY TESTS. Calif. Agr. 18(6): 9-10. 1964.

Costly reconstruction of old compacted golf and bowling greens can be avoided by drilling holes at regular intervals and backfilling with a suitable growth medium, according to the southern California tests. Tests at Arrowhead Country Club, San Bernardino County, in 1961 and 1962 showed that deep aeration plus irrigation control increased root activity and, at the same time, reduced the amount of water needed to maintain acceptable turf during the fall and early winter by 50 to 60 percent. Tests last year at Arcadia, Los Angeles County, substantiated the earlier results with data showing that the 3-inch holes drilled by the usual machine-"aerators" were less effective for healthy regrowth than holes drilled to a depth of 8 inches.

Letey, J. U. Calif., Riverside, Calif.

Dorman, F. W. Farm Advisor, San Bernardino County, San Bernardino, Calif.

30. Harvey, C., Walker, H. J., Whiteley, E. L., and Hipp, B. W. IRRIGATED ROTATIONS ON THE SOUTH PLAINS OF TEXAS. Tex. Agr. Expt. Sta. MP-711. 10 pp. 1964.

An irrigated rotation study consisting of five cropping systems was conducted at the Lubbock Field Station in Texas from 1952-58.

Cotton grown continuously with an annual application of 32 pounds of nitrogen and 40 pounds of phosphorus produced highest yields, averaging 678 pounds of lint per acre per year. When grown continuously without the addition of fertilizer, cotton yielded an average of 499 pounds.

Cotton grown in rotation with Hubam sweetclover averaged 644 pounds. Hubam was not successfully established during most years, therefore, summer fallow and 60 pounds of phosphorus applied to the sweetclover made some contribution to the good yields.

The addition of 80 pounds of nitrogen to a grain sorghum crop increased the yield of grain, but had little carryover effect on the succeeding cotton crop. Wheat, which constituted a part of one cropping system produced low grain yields. The amount of water available for plant use was increased for all rotations, including Hubam clover.

The continuous growth of cotton for 7 years did not alter sufficiently the physical properties of Amarillo fsl as to affect the yields. The organic matter content of the soil was not appreciably affected by the cropping systems.

Soil phosphorus was depleted by continuous cropping. However, high yields could be maintained by the use of commercial fertilizer.

Tex. A&M U., Tex. Agr. Expt. Sta., College Station, Tex.

31. Gerard, C. J., Burleson, C. A., Cowley, W. R., Namken, L. N., and Bloodworth, M. E. COTTON IRRIGATION IN LOWER RIO GRANDE VALLEY. Tex. Agr. Expt. Sta. B. 1014, 15 pp. 1964.

Irrigation spacing experiments for cotton indicated that the water requirement of cotton is dependent upon the soil type which determines the rooting characteristic of the cotton plant. Moisture use on the Harlingen c was restricted mainly to the surface 2 feet of soil because 90 to 99 percent of the roots were found to be in the surface foot of soil. Eighty percent of the roots of the cotton plants growing in Willacy 1 soil were in the top 2 feet of soil. However, moisture use on the Willacy 1 occurred at lower soil depths because some root development was found to occur at 3 to 5 feet.

Maximum demand for moisture by cotton plants started during the early flowering stage and continued until most of the bolls were mature. Additions of water through irrigation or rainfall during this critical water demand period increased cotton yields. Proper timing of irrigation to coincide with stages of maximum use and demand can reduce water use and produce higher yields.

Irrigation schedules for cotton have been proposed for Willacy 1 and Harlingen c soils. Satisfactory yields were produced with a preplanting irrigation and an irrigation about 30 days after appearance of first bloom on the Willacy 1 soil. Satisfactory yields were produced on Harlingen c when the cotton plants were irrigated at approximately 15-day intervals during the blooming and fruiting period.

Close spacing of cotton (3 to 6 plants per foot) increased yields when a high level of soil moisture was maintained.

Tables and graphs.

Tex. A&M U., Tex. Agr. Expt. Sta., College Station, Tex.

32. Bennett, O. L., Doss, B. D., and Ashley, D. A. COTTON IRRIGATION IN SOUTHEASTERN UNITED STATES. U.S. Dept. Agr., Agr. Res. Serv. Inform. B. 282, 16 pp. 1964.

A report on the recommended management practices and types of irrigation for cotton in the southeastern United States was given. The authors concluded that:

1. The management practices employed with irrigation will largely determine whether or not a net profit will be realized.
2. Recommended varieties should be planted as early as possible on well-prepared seedbeds.
3. Fertilizer and lime should be added to the soil according to the recommendations of State agencies.
4. Insect and weed control should be maintained throughout the growing season.
5. Irrigation should be used throughout the growing season when needed by plants, or until lower bolls are open.
6. When lodging is a problem, plants may be topped after heavy fruit set, provided not more than 6 to 8 inches of growth is removed.
7. Cotton should be picked as soon as possible after bolls open, to insure high fiber quality.

ARS, USDA, Inform. Div., Room 645A, FCB, Hyattsville, Md., 20781

33. Colville, W. L., Dreier, A., McGill, D. P., Grabouski, P., and Ehlers, P. INFLUENCE OF PLANT POPULATION, HYBRID, AND "PRODUCTIVITY LEVEL" ON IRRIGATED CORN PRODUCTION. Agron. J. 56(3): 332-335. 1964.

Ten irrigated corn experiments involving 6 hybrids covering a range of maturities and planted at several populations were conducted during 1956-59 in Nebraska. The adapted full season hybrid A.E.S. 806 produced highest average yields at 16 to 20 thousand plants per acre. At greater populations grain yields of this variety were slightly depressed. Yields of early hybrids characterized by Ia. 4417 and Nebr. 201 increased with increasing populations and approached linearity within the limits of these experiments.

Relationships of "productivity level" of hybrid and plants per acre cannot be overlooked by either the corn researcher or the producer. If the maximum yield of each hybrid is to be realized, it must be grown under populations and production practices that maximize its potentials. A limitation of any production factor could well mean the discarding of an excellent hybrid without noting its full potential. Cultural practices for maximum "productivity levels" and high yield potential hybrids cannot be considered to be the same as for corn of 100 bushels per acre or less.

U. Nebr., Lincoln, Nebr.

34. Nelson, C. E. A MANAGMENT EXPERIMENT WITH GAINES WHEAT UNDER IRRIGATION. Wash. Agr. Expt. Sta., Sta. C. 435, 12 pp. 1964.

Gaines winter wheat was seeded in a randomized split-plot design experiment with four replications on September 17 and October 18. Plots of 8.0, 17.7, and 25.4 plants per square foot were combined with nitrogen fertilization studies. Application methods compared were: (1) Broadcasting the fertilizer on the soil surface on March 11; (2) "shanking in" the fertilizer before seeding; and (3) applying half of the fertilizer before seeding and the other half on March 11. Ammonium nitrate was applied at the rates of 40, 80, 120, 160, and 200 lb./N/A.

Plant height differences resulting from time of seeding and time of fertilizer application were negligible. The maximum increase of about 3 inches was obtained from the 120 lb. nitrogen rate versus the 40 lb. nitrogen rate.

Tillering for the September seeding decreased from 3.72 for 8.0 plants/sq.ft. to 3.37 tillers per plant for 25.4 plants/sq.ft.

For the October seeding, the tillers per plant decreased from 3.56 to 3.02 tillers for the same plant populations. Tillering increased with increasing increments of nitrogen fertilizer, the range being 3.09 to 3.72 tillers per plant.

The average yields of grain for the September seeding from all nitrogen rates were 106.5 bu./A. from applying all of the nitrogen fertilizer in the spring, 97.6 bu./A. from one-half in the spring and one-half in the fall, and 86.1 bu./A. for all in the fall. The yields were not significantly affected by the three plant populations in the September seeding.

The October seeding grain yields were increased an average of 4.8 bu./A. by applying all of the nitrogen fertilizer in the spring rather than in the fall. The 17.7 and 25.4 plants/sq. ft. treatments averaged 15.3 bu./A. more than the treatment with 8.0 plants/sq. ft.

For both seedings, the highest straw weights were obtained from spring-applied nitrogen fertilizer, the least from the fall-applied nitrogen. That applied one-half in the spring and one-half in the fall was intermediate.

More total nitrogen was removed by the straw and grain from spring-applied than from fall-applied N fertilizer from the September seeding. This difference did not occur for the October seeding.

The straw and grain from the October seeding removed more total N than that from the September seeding.

The probable reasons why spring fertilization was more effective than fall N fertilization were discussed.

Irrigated Agr. and Ext. Cntr., Prosser, Wash.

35. Stone, J. F., Griffin, R. H., and Ott, B. J. IRRIGATION STUDIES OF GRAIN SORGHUM IN THE OKLAHOMA PANHANDLE, 1958 to 1962. Okla, Agr. Expt. Sta. B. 619, 35 pp. 1964.

Effects of timing of irrigation on the production of grain sorghum were studied from 1958-62 at Goodwell, Okla. Irrigations were timed by a pattern based on growth stages of the plants. The study was designed to reveal which growth stages were critical for water application.

The results indicated that yields suffered if there was plant stress for water prior to and during the boot stage of development. Where the growing season started wet and rains were frequent enough to keep the surface moist, late irrigation (dough stage) were sometimes of value when drought occurred late in the season.

The nitrogen content of the grain seemed to be influenced more by the total amount of water added during vegetative growth than by water timing.

Plant height appeared to vary with favorable timing of irrigation. Timing which enhanced yield enhanced plant height.

Tables.

Okla. State U. Expt. Sta., Stillwater, Okla.

36. Melton, A. A., Wells, J. P., and Fisher, F. L. GRAZING IRRIGATED COASTAL BERMUDAGRASS UNDER DIFFERENT LEVELS OF NITROGEN FERTILIZATION IN THE TRANS-PECOS AREA. Tex. Agr. Expt. Stat. Prog. Rep. 2298, 6 pp. 1964.

Coastal Bermudagrass has, in numerous clipping tests conducted throughout Texas, yielded a tremendous tonnage of forage when both adequate fertilizer and moisture were available. An intense interest has developed among farmers to develop Coastal Bermudagrass meadows and pastures.

Steer calves averaging 260 pounds made satisfactory daily gains from April 29, to July 10, 1963, while grazing Coastal Bermudagrass fertilized at the annual rate of 84, 168, 252, and 336 pounds of nitrogen per acre. The average daily gains per animal to July 10 on the different fertilized plots were 1.04, 0.95, 0.88, and 0.97 pounds, respectively. From July 10 to September 23 the gains of 0.33, 0.50, 0.28, and 0.06 pound daily, respectively, were unsatisfactory. The total gains per acre from April 29 to September 23 were 559, 741, 775, and 720 pounds.

Tex. A&M U., Tex. Agr. Expt. Sta., College Station, Tex.

37. Bezeau, L. M., and Sonmor, L. G. THE INFLUENCE OF LEVELS OF IRRIGATION ON THE NUTRITIVE VALUE OF ALFALFA. Canadian J. Plant Sci. 44(6): 505-507. 1964.

Samples of Ladak alfalfa were obtained over a 3-year period from fertilized plots which were irrigated at 3 levels, namely when available moisture within the root zone had been depleted to 75, 50, and 25 percent levels. The 3-year means of the 50 percent level of minimum available moisture were superior to both the 75 percent and the 25 percent levels in all criteria studied. The 50 percent level produced 19.8 percent more protein per acre, 32.8 percent more digestible cellulose per acre, and

the "nutritive value index" was 4.3 percent higher than the 25 percent level. The 50 percent level produced 4.8 percent more protein per acre, 8.3 percent more digestible cellulose per acre, and the nutritive value index was 4.1 percent higher than the 75 percent level of minimum available soil moisture.

Canada Dept. Agr., Saskatoon, Saskatchewan, Canada.

38. Fischbach, P. E. INCREASE YIELDS, CUT COSTS—IRRIGATE, FERTILIZE IN ONE OPERATION. Nebr. Agr. Expt. Sta. Q. 11(2): 15-17. 1964.

Fertilizing corn and grain sorghums through irrigation water shows promise of increasing yields and cutting costs.

Five field trials (central and western Nebraska, 1962-63) showed a yield increase average of 8 bu./A. and the elimination of one mechanical operation in crop production (Table).

Table - Mechanical vs. applying nitrogen fertilizer in the irrigation water on corn.

Method of application	Acre yield bu/acre
Normal mechanical ¹	116
Normal (mechanical and irrigation split)	120
Normal irrigation (all in one irrigation)	124
Normal irrigation (split into two irrigations)	125
Normal mechanical plus 20# of nitrogen in irrigation water	131

¹Normal-recommended amount of nitrogen determined by a soil test and past cropping history.

The basic parts for metering and injecting fertilizer solutions into a gated pipe or sprinkler system are pump, pressure regulator with bypass, shut-off valve, orifice, two pressure gauges, necessary hoses and fittings, and fertilizer supply tank.

The basic parts for metering and injecting anhydrous ammonia are the ammonia supply tank, pressure regulator, orifice, and a manifold to distribute the ammonia in the irrigation ditch or gated pipe. Most gated pipe and sprinkler systems are equipped with an air inlet valve on the pump discharge pipe. By proper arrangement of pipe fittings, a pressure gauge can be installed and the fertilizer injected at this location.

Solutions of urea, ammonium sulfate, ammonium nitrate, or mixtures of these sources of nitrogen will not cause encrustation or corrosion of irrigation aluminum pipe or fittings. They are recommended for sprinkler, gated pipe, and open ditch distribution systems.

Anhydrous ammonia is not recommended in sprinkler systems because of the high loss of the ammonia (40 percent or more) and plugging of sprinkler nozzles.

Anhydrous ammonia can be used in gated pipe and open ditch irrigation with some irrigation waters. Salts are likely to coat the inside of the gated pipe or siphon tubes. An inhibitor can be used which will reduce the formation of these salts in

hard waters. Inject the inhibitor in the pipe or stream and mix with the irrigation water before injecting the ammonia into the water flow.

Methods used to fertilize in the various types of irrigation systems were given.

U. Nebr. Col. Agr., Agr. Expt. Sta., Lincoln, Nebr.

39. Hughes, W. F., Magee, A. C. ECONOMICS OF LOW-CAPACITY IRRIGATION WELLS: TEXAS HIGH PLAINS. Tex. Agr. Expt. Sta. MP-710, 16 pp. 1964.

A highly effective use is made of water pumped from low-capacity wells in the Texas High Plains. In 1962, the increase in cotton yield attributable to irrigation averaged 34 pounds of lint per acre-inch of water applied where fertilizer was applied, and 21 pounds of lint where no fertilizer was applied.

Special management practices, a rather heavy per acre investment in irrigation facilities, and a long pumping season are required to utilize the low heads of water available for irrigation.

Since the acreage that can be irrigated is highly dependent on seasonal moisture conditions, there is a strong tendency to prepare the land for dry-farming and irrigate as much of it as the available water supply and the season permits. In 1962, cotton was the principal crop grown under both irrigated and dryland conditions. Skip-row planting, predominantly 2 rows planted and 1 row "blank", was a common practice in the production of both irrigated and dryland cotton. Irrigation practices were directly related to planting practices. In preplanting irrigation, water was applied to every furrow. In postplanting irrigation, alternate furrows were watered on solid planted cotton; every third furrow was watered on a 2-in-1-out planting; and, every fourth furrow was watered on 2-in-2-out planted cotton. One preplanting and two postplanting irrigations were the most common practices in 1962.

There was considerable variation in the size and type of pumps, age of development, and drilling depths among wells. With development costs adjusted to reflect 1962 prices, the investment in presently installed irrigation facilities ranged from \$107 to \$166 per allotted acre of irrigated cotton.

Irrigation development is in a process of transition. The size, type, and number of pump replacements in older wells and the type and size of equipment installed in wells developed during the past 4 or 5 years suggests that in some time in the future, most irrigation wells in these resource situations will be equipped with 2-inch submersible pumps. At 1962 price levels for equipment and well installation, the investment required for the acreage irrigated in 1962 with wells equipped with 2-inch submersible pumps ranged from \$98 to \$156 per allotted acre.

Tex. A&M U. Tex. Agr. Expt. Sta., College Station, Tex.

Drainage

SEE ALSO 2, 20, 24, 27.

40. Grover, B. L., and Kirkham, D. SOLVING TILE DRAINAGE PROBLEMS BY USING MODEL DATA. Iowa Agr. Expt. Sta. Res. B. 523: 23-48. 1964.

Over 800 "water tables", in a glassbead-glycerol model were photographed. Data from them were tabulated and graphed to show how water tables fall with time for a large number (109) of different geometries in simulated tile-drained soil. The "soil" was either homogeneous or stratified. The tabulated basic data were depths to water table versus time for the following positions: (1) Midway between pairs of drain tile; (2) above the tiles; and (3) at two intermediate points, so that the whole water table arch was defined. The tile spacings were 50, 100, 200, and 400 cm.; depths below the tile axes to an impermeable barrier were 12 cm. and 0.5 cm. For about half of the 109

geometries, tile discharge rates were measured as they varied with time of water table fall; these discharge rates were presented graphically. The water table and discharge data were for spacings up to 400 ft.

Convenient, dimensionless equations were derived which relate the model data to field conditions. Eight examples of field problems were worked out in numerical detail by use of the derived equations. The tables, graphs, and derived equations aid in understanding and in solving practical drainage problems; furthermore the tables and graphs furnish a source of experimental data for checking theories of falling water tables yet to be discovered. One "defect" which could not be avoided in the data was the approximately 0.75 cm. high "capillary" fringe (apparently resulting more from viscosity than capillarity) of the model. This 0.75 cm. fringe corresponds to about 0.75 ft. of capillary fringe in the field for one modeling scale noted, and about 0.375 ft. for another. Corrections for other capillary fringe heights may be made. The existence of a capillary fringe increases drawdown time. A square-root-of-time "draw-down law" was indicated by the data for many tile drainage situations.

Agr. and Home Econ. Expt. Sta., Iowa State U. Sci. and Tech., Ames, Iowa.

41. Lyons, T., Werenfels, L., and Houston, C. FILTER ENVELOPES AID TILE DRAINAGE: IN SACRAMENTO—SAN JOAQUIN DELTA TESTS. Calif. Agr. 18(3): 14-16. 1964.

Enveloping perforated bituminized fiber and plastic subsurface tile drain in a safflower straw envelope gave excellent performance in maintaining field drainage in Sacramento-San Joaquin Delta tests. A 1-inch glass fiber mat also gave good performance, but tile drains tested without a protecting filter envelope were not successful. The drain failure resulted from sealing by the muck soil, which reduced water movement into the tile—probably a major reason for disappointing experiences with tile in the Delta.

Farm Advisor, Sacramento County, Sacramento, Calif.

42. Nolte, B. H., and Beasley, R. P. THE EFFECT OF FLOW VELOCITY AND TILE JOINT SPACING AND MISALIGNMENT ON THE HEAD EXERTED AGAINST SOIL SURROUNDING FARM DRAIN TILE. Mo. Agr. Expt. Sta. Res. B. 852, 14 pp. 1964.

One limit to the use of drain tile on steep grades is the lack of design data. Tile joints were tested to determine if the head outside the tile joint was affected by changing the tile joint spacing or misalignment.

Misalignment of the tile joint caused the head outside the joint to differ from the static head inside the tile at the joint. As the velocity was increased, the difference between the head outside the tile joint and the static head inside the tile increased. A velocity of 4 feet per second caused a difference in head between plus 0.2 foot of water on one side of the tile joint, and minus 0.1 foot of water on the opposite side of the tile joint. A velocity of 12 feet per second caused a difference in head between plus 1.3 feet of water on one side of the tile joint and minus 0.4 foot of water on the opposite side of the joint.

Varying the tile joint spacing had little effect on the head outside the tile joint. For practical application, the variation of the head outside the joint caused by changing the joint spacing can be neglected.

Misalignment of the tile should be considered in the design of drain tile lines. By adding the increase due to misalignment to the static head in the tile, the total head against the soil can be obtained.

For a proposed tile installation, the permissible head against the soil can be estimated and compared to the maximum head that will develop. The possibility of failure due to excessive head can then be predicted.

The results may be applied to the design of drain tile terrace outlets. Precise limits to the conditions under which drain tile would be practical were not given, but some general guide lines were suggested.

U. Mo., Agr. Expt. Sta., Columbia, Mo.

43. Tovey, R. WATER TABLE FLUCTUATION—EFFECT ON ALFALFA PRODUCTION. Max C. Fleischmann Col. Agr. Tech. B. 1, 11 pp. 1964.

Much of the irrigated land devoted to the production of forage crops in the Southwestern States is affected to some degree by high water tables. Alfalfa can adapt to static high water table conditions and maintain a good production level, but fluctuating water tables that inundate the alfalfa root system for extended periods will greatly reduce production or kill the plants.

Design criteria for surface irrigation, subirrigation, and drainage require information on the duration of waterlogging or flooding tolerated by crops. The results of research concerned with the effects of fluctuating water tables on the yield and growth stage of alfalfa were given.

The frequency and duration of water table fluctuations must be controlled to sustain alfalfa production. Significant results of the lysimeter study were: (1) Excess water must be removed from the root zone of alfalfa plants adapted to 2-foot static water tables within 3 days to insure optimum crop production; and (2) alfalfa root system deterioration became progressively worse as the fluctuation or submergence intervals exceeded 4 days.

Max C. Fleischmann Col. Agr., U. Nev., Reno, Nev.

Storage and Conveyance

SEE ALSO 20, 23, 106, 249, 250.

44. Hall, W. A. OPTIMUM DESIGN OF A MULTIPLE-PURPOSE RESERVOIR. J. Hydraul. Div., ASCE 90 (HY 4): 141-149. 1964.

A method for the optimum design of a reservoir to provide regulated water for several purposes was described that separately allocates the water to the different purposes and then allows for the use of some of the water for more than one purpose. Dynamic programming was used to effect the optimum allocation in terms of a number of different values of regulated flow. Flood control storage was considered separately in terms of marginal cost and marginal benefit. The limitations of the approach arise from the limitations of the concept of "regulated flow." Extensions to overcome the limitations were indicated.

U. Calif., Los Angeles, Calif.

45. Spraberry, J. A., ed. SUMMARY OF RESERVOIR SEDIMENT DEPOSITION SURVEYS MADE IN THE UNITED STATES THROUGH 1960. U.S. Dept. Agr. Misc. Pub. 964, 61 pp. 1964.

A summary of the data from all known reliable reservoir sedimentation surveys made in the United States through 1960 was given. This bulletin includes: Reservoir surveys reported in Bulletin No. 6; surveys made prior to 1953 but not included in Bulletin No. 6; and new data on reservoirs that have been surveyed or resurveyed since 1953. Data were summarized for 1,069 reservoirs. These reservoirs are located in 48

States and Puerto Rico. No surveys have been reported for Florida and Maine. In addition to the data on storage reservoirs and stock ponds, some information was included on debris basins.

Glymph, L. M., Jr., SWCRD, ARS, USDA, Beltsville, Md., 20705

46. Crow, F. R. WIND EFFECTS ON CHEMICALS FOR REDUCING EVAPORATION: FROM SMALL RESERVOIRS. Okla. Agr. Expt. Sta. Proc. Ser. P-477, 37 pp. 1964.

The effects of monolayer forming chemicals on water evaporation from small reservoirs were determined and systems of floating barriers designed to reduce wind-induced losses of the chemical monolayer were evaluated.

The experimental investigation was carried out on paired ponds and included tests of: (1) Apparatus to continuously replenish the monolayer at the upwind shore; (2) open picket type baffles to reduce the wind speed near the water surface; and (3) completely closed barriers to reduce the wind speed and confine the monolayer within a small bay or compartment.

Wind speed versus film application rate curves were determined through the use of the experimental monolayer application apparatus. The required film application rate was a power function of the wind speed having the equation $R = 9.3 U^{2.02} \times 10^{-6}$, where R is the rate of chemical application in pounds per hour per foot normal to the wind, and U is the wind speed in miles per hour.

The effectiveness of open picket type baffles to reduce the wind speed and film movement was studied. Baffles with 57 percent open spaces and 1.2 ft. height were moored on the water surface on a 14.5 ft. grid. They reduced film removal about 20 percent during 8 m.p.h. winds but had no effect on the film requirement at 12 m.p.h. winds. The equation for this curve was $R = 2.8 U^{2.51} \times 10^{-6}$. The open baffle had little practical value.

A network of completely closed barriers were much more effective as an anti-wind measure. With these barriers, arranged similarly to the open baffles described above, evaporation was reduced 9 percent, without the aid of monolayers. Average wind speed during this test was 10 m.p.h. Linear relations between the evaporation retardation and the wind speed were developed which showed an increase in evaporation retardation with increasing wind speed.

The closed barriers were effective in preventing the monolayer from escaping. This prolonged the effective life of the monolayer and a new supply of monolayer forming chemical was needed only at 3 to 6 day intervals. The area of each compartment occupied by the monolayer was a function of the wind speed and of the barrier spacing to height ratio, (L/H). Relations between these variables were developed and shown graphically. The most effective barrier spacing/height ratio tested was $L/H = 16$, which provided a complete film cover during all wind speeds less than 10 m.p.h.

Evaporation suppression tests were made with monolayers formed by a mixture of C_{16} and C_{18} fatty alcohols. The barrier spacing to height ratio was an important factor. When the barriers were set at $L/H = 58$, evaporation was reduced 11 percent. The best evaporation suppression results were obtained when the monolayer was used in combination with the closed barriers set at $L/H = 16$. Evaporation reduction then was from 30 to 40 percent. This was achieved during normal Oklahoma winds and with only periodic replenishment of the film. A system of wind/film barriers of this type, in combination with monolayers of fatty alcohol, holds promise for evaporation control on small impoundments.

Tables, graphs, and photographs.

Okla. State U. Expt. Sta., Stillwater, Okla.

BASIC SOIL SCIENCE

Soil Physics

SEE ALSO 2, 6, 7, 21, 25, 27, 28, 29, 46, 84, 94, 95, 98, 101, 104, 109, 117, 134, 136, 140, 189.

47. Gates, D. M. LEAF TEMPERATURE AND TRANSPIRATION. Agron. J. 56(3): 273-277. 1964.

The mechanisms which contribute to the energy exchange for a leaf were described and a graphical solution to the heat transfer equation for a leaf was presented. The importance of transpiration for cooling a leaf was shown in quantitative form. The complete energy budget for a leaf of Quercus macrocarpa was observed at various times of day including radiation, convection, transpiration, and leaf temperature. Good agreement was realized between the energy absorbed by the leaf and the energy consumed by dissipative mechanisms.

Inst. Artic and Alpine Res., U. Colo., Boulder, Colo.

48. Allen, L. H., Yocum, C. S., and Lemon, E. R. PHOTOSYNTHESIS UNDER FIELD CONDITIONS. VII. RADIANT ENERGY EXCHANGES WITHIN A CORN CROP CANOPY AND IMPLICATIONS IN WATER USE EFFICIENCY. Agron. J. 56(3): 253-259. 1964.

Data were collected which gave sinks for shortwave radiation within a corn crop. Net radiation above a corn crop canopy, and at 4 levels within the crop, 225, 175, 100, and 20 cm., were collected for the afternoon of September 10, 1961. The data were extrapolated back through the morning hours.

Transmission measurements with a Miller field light transmission photometer showed that shortwave transmission can be expressed as an exponential function of height as well as leaf area index.

Net thermal radiation was calculated for the 5 heights at 15-minute intervals from 1230 to 1700 hr. Net thermal radiation appeared to be an exponential function of height down through 100 cm. Anomalies appearing in the net thermal radiation profiles around noontime were attributed to leaf and row orientation effects.

A photosynthetic efficiency of 6.8 percent from the 0.4 to 0.7 μ radiation was obtained from harvested plant dry matter accumulation data. Using Beer's law for light absorption, potential photosynthesis by layers was calculated for the whole day. Using net radiation data, potential transpiration/potential photosynthesis ration on an energy basis was 16.

From soil heat flux data, soil evaporation was calculated. For the entire day, it was estimated that 17 percent of the total evapotranspiration could be direct evaporation from the soil.

Tables and graphs.

Lemon, E. R., SWCRD, ARS, USDA, Ithaca, N.Y.

49. Koberg, G. E. METHODS TO COMPUTE LONG-WAVE RADIATION FROM THE ATMOSPHERE AND REFLECTED SOLAR RADIATION FROM A WATER SURFACE. U.S. Dept. Int., Geol. Survey Prof. P. 272 F: 107-136. 1964.

Methods were presented for computing long-wave radiation from the atmosphere and reflected solar radiation from a water surface. The parameters needed to compute the long-wave radiation were air temperature, air-vapor pressure, and the ratio of measured solar radiation to clear-sky solar radiation. The long-wave determination was based on

Brunt's equation in which the atmosphere is treated as a gray body. Computations by this method were made at 11 stations for periods of a week or longer and compared to long-wave radiation measurements made with a flat-plate radiometer. The average difference, without regard to sign, between the computed and the measured long-wave radiation was 5.2 percent or less for 9 of the 11 stations. The method for determining reflected solar radiation required only a measurement of solar radiation and was accurate within 10 percent.

Long-wave radiation from the atmosphere and reflected solar radiation from a water surface are important factors in the energy-budget equation for determining evaporation. The U.S. Geological Survey obtained direct measurements, of the received and reflected radiation for periods of from 1 to 2 years at a number of reservoirs in the arid West that lie in an area between lat. 30° and 40° N. and long. 95° and 125° W. The moisture content of the atmosphere ranges from low, in the dry desert regions, to high, in the areas near the Gulf of Mexico. Data were obtained at locations ranging in altitude from near sea level to 10,000 feet.

The received and reflected radiation measurements were used in a study of the relation of long-wave radiation to certain atmospheric characteristics such as temperature, vapor pressure, and cloud cover.

Supt. Doc., U.S. Govt. Print. Off., Washington, D.C., 20402

50. Gardner, W. R., and Nieman, R. H. LOWER LIMIT OF WATER AVAILABILITY TO PLANTS. Sci. 143 (3613): 1460-1462. Mar. 27, 1964.

Measurements of transpiration, cell division, and cell enlargement show that no single lower limit of available water can be defined for these three plant processes. The soil-water content at which permanent wilting is exhibited does not represent a true lower limit for any of these.

U.S. Salinity Lab., SWCRD, ARS, USDA, Riverside, Calif., 92502

51. Wiggans, C. C. DEPLETION OF SUBSOIL MOISTURE BY APPLE TREES AND OTHER WOODY SPECIES. Nebr. Agr. Expt. Sta. Res. B. 216, 32 pp. 1964.

Moisture determinations made following drought years of the early thirties showed available moisture near exhaustion to depths of 30 feet or more in mature apple orchards. As distance from the tree trunk increased or lower levels were reached, the depletion was less severe. Moisture depletion was correlated with the number of trees per acre.

Short-lived varieties, such as Grimes, apparently depleted the soil moisture more rapidly or more completely than the long-lived Winesap group.

Subsoil moisture content varied with moisture demand of the cover crop but a little mulch conserved moisture.

The effect of newly planted trees upon subsoil moisture was slight but with the approach of bearing age, depletion of available water was significant.

Replenishment of subsoil moisture in an old orchard site was so slow that newly planted trees were handicapped. Twenty-year-old Jonathan trees near Nebraska City had used more than 50 percent of the available water and 2 years later more than 70 percent. The actual annual water loss from the top 30 feet of this orchard site soil averaged more than 5 inches.

Under controlled conditions, 43 inches of irrigation water raised the soil moisture content to field capacity to a depth of at least 30 feet in a block of mature Delicious trees. Between November 1937 and October 1940, the available moisture content was reduced from 72 to 42 inches in this block of 18-21-year-old trees. The yearly evapotranspiration varied from 31.14 to 27.05 inches.

In another controlled experiment involving newly planted trees, there was little change in subsoil moisture content between 1943 and 1952, but in the following year there was noticeable depletion.

Vineyard moisture requirements apparently are lower than those for tree fruits.

Deciduous forest species, after exhausting all available moisture from the subsoil, must exist on annual precipitation if they are to survive.

White pines apparently exhaust the available moisture to about 25 feet. Removal of these trees resulted in considerable recovery of subsoil moisture in the upper 15 feet during the next 2 years.

U. Nebr. Col. Agr., Agr. Expt. Sta., Lincoln, Nebr.

52. Shaw, R. H. PREDICTION OF SOIL MOISTURE UNDER MEADOW. Agron. J. 56(3): 320-324. 1964.

Soil moisture under meadow was estimated for June, early August, and early November by using April, June, and August soil moisture survey data as the starting points. All computations were made on the amount of plant available water present in the 5-foot profile.

Evapotranspiration was estimated as a percent of open-pan evaporation. Early in the season, it was 0.35 times pan evaporation and increased to 0.80 times pan evaporation by Mar. 2. Evapotranspiration continued at this rate until cutting, when it was assumed to drop to 0.33 times pan evaporation. The rate gradually increased to the maximum as regrowth occurred. Starting September 12, a gradual decrease in the evapotranspiration rate was assumed, until, by late October, it reached a minimum of 0.35 times pan evaporation. When necessary, a factor was used to account for the effect of moisture stress.

Precipitation amounts were added to the soil moisture supply after deducting for runoff. An antecedent precipitation index was used to compute runoff.

For the April-June period, the correlation between the observed (X) and predicted soil moisture (Y) was 0.97 with a linear regression of $Y = 0.41 + 0.92X$ and standard deviation from regression of 0.62 inch. The second foot was estimated an average of 0.21 inch low; other foot increments were within 0.1 inch of the observed value.

For the June-August period, the correlation was 0.97 with a linear regression of 0.75 inch. The individual foot increments averaged near 0.1 inch of the observed values.

For the August-November period the correlation was 0.98 with a linear regression of $Y = 0.03 + 0.99X$ and standard deviation from regression of 0.74 inch. Each foot increment averaged within 0.1 inch of the observed value.

Iowa Agr. and Home Econ. Expt. Sta., Ames, Iowa.

Soil Chemistry and Minerology

SEE ALSO 2, 30, 63, 73, 79, 81, 82, 84, 85, 88, 92, 93, 95, 99, 101, 105, 106, 110, 114, 117, 120, 122, 123, 126, 128, 134, 135.

53. McLean, E. O., and Franklin, R. E., Jr. CATIONIC ACTIVITIES IN CLAY SUSPENSIONS AND EQUILIBRIUM DIALYZETES. Soil Sci. 97(4): 260-267. 1964.

Suspensions of bentonite and illite clays with various saturations of Ca and K were equilibrated with equal volumes of water (dialyzate), using semipermeable membranes (Donnan) to separate the two phases. The activities of Ca and K in the suspension and dialyzate phases were determined by the clay membrane electrode technique. The concentrations (approximate activities) of these cations in the dialyzates were also determined by the flame photometric method. The results were summarized as follows:

1. The relative activities of both Ca and K in bi-ionic systems were successfully obtained by either the clay membrane electrode or the Donnan equilibration method. The electrode method was comparatively rapid and may be more accurate at low concentration, but it was limited to fewer kinds of ions in the system than the membrane equilibration method.
2. A combination of the two methods appeared to be even more revealing than either alone. Greater cationic activities measured in the suspension than in the dialyzate phase (suspension effect) by the clay membrane electrodes for Ca and K in the bentonite, and for Ca only in the illite, evidently result from the contribution of dissociated ions from the exchange sites to the total activity.
3. The fact that the suspension effect for Ca was obtained is particularly significant, since the Ca activities were computed from the difference in the emf between two cells using the same calomel electrodes, thus eliminating any possibility for liquid junction potential as a source of error.
4. The greater activity of cations in the suspension phase than in the dialyzate phase appeared to be significant in causing increased uptake by plants from the suspension phase.
5. The relatively strong bonding of Ca by bentonite and the pronounced effect of small quantities of electrolyte on the separation of Ca from this clay was demonstrated.
6. Most of the Ca and K in the various systems and phases of each system was either displaced by electrolyte (or hydrolysis) or adsorbed to the clay. Small amounts of dissociated ions evidently accounted for the suspension effect.
7. The relative saturation of the colloid with Ca and K and the consequent effect of bonds of different strengths affected the ease of displacement of both cations by added electrolyte and by hydrolysis.

Ohio State U., Wooster, Ohio.

54. McLean, E. O., Hourigan, W. R., Shoemaker, H. E., and Bhumbra, D. R. ALUMINUM IN SOILS: V. FORM OF ALUMINUM AS A CAUSE OF SOIL ACIDITY AND A COMPLICATION IN ITS MEASUREMENT. Soil Sci. 97(3): 119-126. 1964.

Several acid soils from Ohio, varying widely in contents of soluble Al, were studied. Some were leached with AlCl_3 and HCl acid solutions, while others were limed at various rates. The various kinds of acidity were determined and interpreted. The author concluded that:

1. One normal KCl solution removed only about a sixth to a quarter of the acidity from the untreated soils, which were more than 80 percent acid-saturated. Acid leaching (AlCl_3 or HCl) increased the exchangeable acidity (KCl extractable) from 2-1/2-fold to 6-fold.
2. AlCl_3 leaching increased the exchangeable Al over HCl leaching, but only brought the exchangeable Al to about 50 percent of the exchangeable acidity.
3. The "quick" test buffer methods for lime requirement, based on change in pH of the buffer by the acid soil, were subject to the activity of the form of acidity present. The activity of the various forms of acidity appeared to be as follows: permanent charge H^+ > permanent charge Al^{+++} > hydroxy-Al monomers > hydroxy-Al polymers $\approx$ organic matter acidity $\approx$ lattice Al-HO or Si-OH acidity. Thus when a soil was artificially enriched with a more active form of acidity, a "quick" test method which satisfactorily measured the less active acidity of field soils indicated much more acidity than was actually present.

4. Hydroxy-Al and $\text{Al}(\text{OH})_3$ formed by addition of lime to soils remained extractable with NH_4OAc -pH 4.8 for at least 2 weeks, but they were only slightly extractable with N KCl . After long periods of moist equilibration and drying, these forms of Al also became only slightly extractable with NH_4OAc .
5. The addition of lime decreased both the exchangeable (KCl) acidity and the pH-dependent acidity in the soil. The change in the pH-dependent acidity with liming appeared to be mainly the effect of hydroxy-Al ions (polymers), which were not readily exchangeable with KCl . The change in buffer-measured (Mehlich) acidity per increment of lime added was about three-fourths the equivalent of the lime.

Ohio State U., Columbus, Ohio.

55. Martens, D. C., Chester, G., and Murdock, J. T. AVAILABLE ZINC STATUS OF WISCONSIN SOILS AS DETERMINED BY ASPERGILLUS NIGER. Agron. J. 56(3): 262-265. 1964.

An Aspergillus niger bioassay was used to determine the Zn status of 57 Wisconsin soils. Control of contaminating microorganisms in the nutrient solution was achieved by the addition of 3.8 g./l. of oxalic acid. The choice of oxalic acid was based principally on its ability to buffer the nutrient solution against added soil samples; HCl , H_3PO_4 , and tannic acid were found less suitable. From the growth rate of A. niger, an 8-day incubation was deemed optimum for the bioassay. The capability of the A. niger Zn assay for predicting uptake of Zn by corn plants grown in the greenhouse was determined and the effects of soil pH and contents of clay and organic matter on the prediction were evaluated by multiple regression analyses.

Using all 57 soil samples, a simple correlation coefficient of 0.539 was obtained between uptake of Zn by corn plants and the A. niger test. By including soil pH and clay in the above correlation, the correlation coefficient was raised to 0.780. Partial correlation and standardized partial regression coefficients indicated that the A. niger test value was approximately twice as important as soil pH or clay content in predicting the availability of soil Zn.

U. Wis., Madison, Wis.

56. Nikishkina, P. I. EFFECT OF THE PROLONGED USE OF ORGANIC AND MINERAL FERTILIZERS ON THE AVAILABILITY OF MICRO-ELEMENTS IN THE SOIL. Soviet Soil Sci. 9: 825-830. Sept. 1963.

The influence of the long-term addition of organic and mineral fertilizers on the content and availability of micro-elements in typical soils was determined in Russia. The author concluded that:

1. The systematic application of mineral and organic fertilizers to sod-podzolic soils changed not only the content of macro-elements in them, but also that of available forms of micro-elements.
2. The application of manure increased the content of total and water-soluble boron. This increase varied from 0.05 to 0.132 p.p.m. of soil for water-soluble boron in various soils. The systematic application of mineral fertilizers (NPK) resulted chiefly in a decrease in the content of total and water-soluble boron in the soil.
3. The amount of molybdenum entering the oxalate extract increased in all the manured soils. The increase in the content of available molybdenum in the soil after the systematic application of manure ranged from 0.004 to 0.067 p.p.m. of soil in various soils. No reliable changes were found in the content of available molybdenum in the soils as a result of application of mineral fertilizers.

4. The application of manure produced an increase of the amount of cobalt entering a 1.0 N nitric acid extract in the soil. This increase varied from 0.1 to 0.30 p.p.m. of soil in various soils.
5. The systematic addition of manure in the crop rotation enriched the soil with available forms of boron, molybdenum, and cobalt. At the same time acidity decreased and the content of humus and of available forms of phosphorus and potassium increased.

Scripta Technica Inc., 1000 Vermont Ave., N.W., Washington, D.C., 20005

57. Boswell, F. C., and Anderson, O. E. NITROGEN MOVEMENT IN UNDISTURBED PROFILES OF FALLOWED SOILS. *Agron. J.* 56(3): 278-281. 1964.

The rate and depth movement of N applied as potassium nitrate was studied on two widely different fallowed soils under field conditions. The authors concluded that: (1) Almost all of the applied N was found in 0-3 and 3-6 inch layers after 5 weeks and 2 inches of rainfall on a Lloyd scl and 1.5 inches of rainfall on a Marlboro ls; (2) after 20 weeks and 27 inches of rainfall on the sandy clay loam, and 17 weeks and 10.3 inches of rainfall on the loamy sand, almost all of the applied N was still found in the top 2 to 3 feet of both soils; (3) appreciable upward movement of N may have occurred from depths of 5 to 6 feet during moisture stress; (4) both soil texture and amount of rainfall influenced the N movement; and (5) even with high accumulated rainfall, appreciable amounts of the applied N were evident at 36- to 72-inch depths 76 weeks after N was applied to the fallowed plots.

Ga. Agr. Expt. Sta., U. Ga. Col. Agr., Experiment, Ga.

58. Fiskell, J. G. A., and Spencer, W. F. FORMS OF PHOSPHATE IN LAKELAND FINE SAND AFTER SIX YEARS OF HEAVY PHOSPHATE AND LIME APPLICATIONS. *Soil Sci.* 97(5): 320-327. May 1964.

Triple superphosphate (TSP) at rates of 800, 3,200, and 12,800 pounds P per acre was applied, with and without limestone, to Lakeland fs in 18 applications over a period of 6 years. Total P analysis of samples taken to a depth of 48 inches indicated that this soil retained all the P applied at both the lowest and medium rates and 57 percent at the highest rate. Lime applied with the TSP altered the distribution of P in profiles that received the highest but not the medium and lowest rates in comparison to those with the same rates of TSP without lime. The concentration of accumulated P decreased consistently with depth.

Selective dissolution analysis was used to determine the forms of the accumulated P. The native soil P was principally an iron form with lesser amounts of Al and Ca phosphates present. At the lowest rate of TSP without lime, the P accumulated as Al phosphates along with lesser amounts of DCPD, Fe phosphates, and Octocalcium phosphate (OCP) or hydroxyapite (HAP). Were lime was used with the lowest rate of TSP, the P accumulated as 50 percent Al phosphates and the rest as Fe and Ca phosphates. At the medium rate without lime, 57 percent of the applied P accumulated in the Al phosphates, 13 percent as Fe phosphates, 6 percent as DCPD, and 4 percent as OCP and HAP. At the medium rate with lime, 47 percent accumulated as Al phosphates, 25 percent as Fe phosphates, 12 percent as DCPD, and 19 percent as OCP and HAP. At the highest rate of TSP without lime, 66 percent of the accumulated P was in the Al forms, 17 percent in the Fe forms, 11 percent as DCPD, and 6 percent as OCP and HAP. With the lime mixed with the same amount of TSP, 35 percent of the P accumulated as Al phosphates, 7 percent as the Fe phosphates, 12 percent as DCPD, and 41 percent as OCP and HAP. Organic P and occluded Fe and Al phosphates were not included. Total recovery of P by the sequential dissolution technique was nearly equal to that found by total P analysis.

U. Fla., Fla. Agr. Expt. Sta., Gainesville, Fla.

59. Blanchar, R. W., and Caldwell, A. C. PHOSPHORUS UPTAKE BY PLANTS AND READILY EXTRACTABLE PHOSPHORUS IN SOILS. Agron. J. 56(2): 218-221. 1964.

Plant uptake of P from calcareous and noncalcareous soils was correlated with P forms in soils and chemical estimates of available P. Some other chemical properties of soils which affect plant uptake and chemical estimation of available P were examined.

Calcium phosphates comprised the major form of P in calcareous soils; iron and aluminum phosphates were the major form in noncalcareous soils. No apparent relationship existed between plant uptake of P and total calcium phosphates or iron and aluminum phosphates in either type of soil. However, in calcareous soils the more soluble calcium phosphates were significantly correlated with plant uptake of P.

In calcareous soils, a significant correlation was found between plant uptake of P and Bray No. 1 (soil: solution ration 1:50), the Morgan method, anion exchange resin, and sodium bicarbonate estimates of available P. Available P as indicated by Bray No. 1 extraction with a soil to solution ratio of 1 to 10 was not significantly correlated with plant uptake of P.

The amount of calcium carbonate was shown to be inversely related to the Bray No. 1 estimate of available P. Calcium carbonate equivalence was not related to Bray No. 1 extractable P. This relationship was found only when lime present as dolomite was subtracted from the total calcium carbonate equivalence.

In noncalcareous soils, all methods used to estimate available P were significantly correlated with plant uptake of P. The highest correlation was obtained with the Morgan and water-soluble estimates of available P.

Various chemical estimations of available P currently in use gave relatively good measures of the capacity of the soil to supply P to plants. It would appear that in working with soils of similar chemical characteristics (calcareous or noncalcareous) P extraction methods should be selected which will more accurately describe differences in plant available P.

U. Minn., St. Paul, Minn.

60. Jenks, E. M., Raese, J. T., and Reese, C. D. ORGANIC PHOSPHORUS CONTENT OF SOME WEST VIRGINIA SOILS. W. Va. Agr. Expt. Sta. B. 489, 16 pp. 1964.

Organic phosphorus, phytin phosphorus, total and available phosphorus, and pH were determined in samples from the A and B horizons of 34 widely distributed West Virginia soils.

Organic phosphorus varied in surface samples from 70 p.p.m. to 827 p.p.m. and averaged 256 p.p.m. Subsoil samples were generally lower, ranging from 28 p.p.m. to 589 p.p.m. and averaging 136 p.p.m. As a percentage of total phosphorus, organic phosphorus ranged from 7.0 percent to 65.8 percent in surface samples and averaged 42.3 percent. The range in subsoil samples was 13.4 percent to 54.9 percent with an average of 27.7 percent.

Statistical correlations of organic phosphorus with total phosphorus and organic matter were highly significant. Correlations with available phosphorus and pH were not significant. With pH, it was just short of significance at the 5 percent level.

The ratio of organic phosphorus to organic matter was less, on the average, in surface samples than in subsoil samples, being 1:155 and 1:103, respectively.

There was little difference among regions with respect to organic phosphorus content. Soils higher in organic matter and total phosphorus tended to be higher in organic phosphorus regardless of region. Poorly drained soils as a group, because of their higher contents of total phosphorus and organic matter, were higher in organic phosphorus than well-drained soils.

Phytin phosphorus constituted an appreciable portion of the total phosphorus in the soils investigated. Surface samples ranged from 75 p.p.m. to 750 p.p.m. and averaged 245 p.p.m. Subsoil samples were generally lower in phytin, varying from 25 p.p.m. to 500 p.p.m. and averaging 136 p.p.m. On the basis of percentage of the total phosphorus, the variation in surface samples was from 13.3 percent to 63.1 percent and the average was 39.1 percent. Subsoil samples were usually lower than surface samples, varying from 10.1 percent to 47.9 percent and averaging 28.9 percent.

Statistical correlations of phytin phosphorus with organic phosphorus, total phosphorus, and organic matter were highly significant. As with organic phosphorus, phytin phosphorus did not correlate significantly with available phosphorus or pH.

W. Va. U. Agr. Expt. Sta., Morgantown, W. Va.

61. Mandal, L. N. EFFECT OF TIME, STARCH, AND LIME ON THE TRANSFORMATION OF INORGANIC PHOSPHORUS IN A WATER-LOGGED RICE SOIL. Soil Sci. 97(2): 127-132. 1964.

The transformation of soil inorganic phosphorus in water-logged soils was investigated to understand the nature of the processes by which it is rendered available to rice plants grown in such soils. Soil samples were kept under water-logged conditions in three sets of test tubes (5 g. per test tube), treated respectively, as follows: No treatment (control); lime; and starch. At periodic intervals, the supernatant water and the soil samples were analyzed, the former for water-soluble phosphate only and the latter for 0.5 N acetic-acid-extractable phosphate, saloid-bound phosphate (N acetic-acid-extractable phosphate), and aluminum, ferric, and calcium phosphates. On water-logging, control samples showed a slight increase in 0.5 N acetic-acid-extractable phosphate, accompanied by a slight decrease in the ferric phosphate; aluminum and calcium phosphates remained practically unchanged.

In the presence of starch, 0.5N acetic-acid-extractable phosphate showed a considerable increase along with a decrease in the calcium phosphate fraction. Although a large amount of ferrous iron was formed, the ferric phosphate fraction showed practically no decrease, and aluminum phosphates no change.

In the presence of lime, ferric and aluminum phosphates decreased, the former considerably, the latter very slightly. Calcium phosphate was increased appreciably in the presence of lime. The effect of lime seemed to be to convert some of the ferric phosphate to calcium phosphate. It was suggested that, in acid soils having most of the inorganic phosphorus as ferric phosphates, the use first of lime and then of organic matter will result in an increase in the availability of soil phosphorus under a water-logged condition.

Central Sericultural Res. Sta., Berhampore (West Bengal), India.

62. Fox, R. L., and Kacar, B. PHOSPHORUS MOBILIZATION IN A CALCAREOUS SOIL IN RELATION TO SURFACE PROPERTIES OF ROOTS AND CATION UPTAKE. Plant and Soil 20(3): 319-330. 1964.

Several legume and grass species, having roots of widely different cation-exchange capacities, were grown in pots for 4 to 6 months on highly calcareous Turkish soil.

Following the growth of the original crops, an indicator crop (barley or lettuce) was grown to evaluate changes in the phosphorus status of the soil. Soluble soil phosphorus and exchangeable potassium and sodium were extracted before and after the original cropping. Amounts of phosphorus, potassium, and sodium removed by cropping were determined.

Lettuce, and especially barley, which grew after legumes yielded more and contained more phosphorus than did barley or lettuce which followed grasses. Although there was evidence of greater phosphorus mobilization concurrent with legume growth (having roots with high cation-exchange capacity), than with grasses (having roots with low cation-exchange capacity) there was little evidence that differences among legumes or grasses in phosphorus mobilized for the succeeding barley crop was related to the cation-exchange properties of the roots. A little more phosphorus was extracted by three extracting solutions from soils which had grown legumes.

Grasses utilized relatively large amounts of soil potassium while legumes utilized relatively large amounts of calcium by comparison. As a result, the ratio Ca/K in lettuce and barley which followed these crops was changed considerably. For barley, the ratio was about 0.9 following grasses and about 0.4 following legumes.

Growth of grasses and legumes brought about drastic changes in the cation status of the soil and plant. It was suggested that the cation (especially calcium and potassium) environment adjacent to the plant root may have been altered sufficiently to influence phosphorus solubility and thus its availability.

Hawaii Agr. Expt. Sta., U. Hawaii, Honolulu, Hawaii.

63. Abdel Salam, M. A., Sabet, S. A., and Hashish, S. PATTERNS OF FIXATION OF P^{32} -LABELLED PHOSPHATE BY SOME SOIL MINERALS. Plant and Soil 20(2): 241-250. 1964.

The effect of grain size and concentration of clays, calcium carbonate, and sulphate on the magnitude of changes in phosphate fixation were studied.

An isotope technique using $NaH_2P^{32}_4$ was adopted. It was concluded that:

1. P-32 fixation by clays increased with raising the clay concentration. The curves acquired a slightly parabolic shape suggesting other mechanisms than those related to the clay content of calcium, iron or aluminum. The magnitude of fixation was in accordance with the number of OH^- sites in the clay mineral. Thus Wadi El-Arish clay, which is mostly kaolinite, showed the highest fixation capacity.
2. Fixation by calcium carbonate increased linearly with concentration. Fixation also increased with decreasing particle size.
3. Fixation by calcium sulphate was not affected by particle size. Raising the gypsum concentration up to the level of 1 g. per 100 ml. water increased phosphorus fixation correspondingly. Above this critical level fixation decreased with the increasing gypsum concentration. This was explained in view of the isomorphic replacement that could have taken place between the calcium sulphate and phosphate crystals.

No address given.

Soil Biology

SEE ALSO 55, 106, 137, 217.

64. Benjamin, C. R., Haynes, W. C., and Hesseltine, C. W. MICRO-ORGANISMS: WHAT THEY ARE: WHERE THEY GROW: WHAT THEY DO. U.S. Dept. Agr. Misc. P. 955, 36 pp. 1964.

A review of micro-organisms was given to provide a background for the understanding of microbial processes. It was prepared at the Northern Regional Research Laboratory, where investigations are being conducted on the industrial utilization of cereal grains and oilseeds by fermentation. The ARS Cultural Collection, maintained

there, is one of the world's most complete collections of industrially important bacteria, molds, actinomycetes, and yeasts. The Cultural Collection serves as a source of authentic micro-organisms for the fermentative production of organic acids, vitamins, antibiotics, enzymes, feeds, beverages, and foods.

ARS, USDA, Inform. Div., Room 645A, FCB, Hyattsville, Md., 20781

65. Young, J. L. AMMONIA AND AMMONIUM REACTIONS WITH SOME PACIFIC NORTHWEST SOILS. Soil Sci. Soc. Amer. Proc. 28(3): 339-345. 1964.

Retention and fixation of NH_3 and NH_4^+ by 76 horizon samples from 20 different Pacific Northwest soils were investigated using aqua and anhydrous NH_3 , NH_4Cl , and different degassing and fixing conditions.

Retention of NH_3 by ammoniated air-dry samples was approximately 0.7 me. N per each me. of soil cation-exchange capacity. In the surface horizons, retention of NH_3 was roughly 0.3 and 2.6 me. N per 100g. of soil for each percent clay and organic carbon, respectively.

Ratios of " NH_3 retained by air-dry ammoniated samples" to " H_2O retained by the air-dry samples prior to ammoniation" ranged from 0.03 to 0.19 but were generally < 0.1.

As with expandable lattice minerals, vacuum degassing increased NH_3 retention substantially beyond that of free diffusion degassed samples open to moisture of the atmosphere. Loss of retained NH_3 by diffusion and/or water vapor displacement continued at a slow rate for many weeks and while total retention was decreasing, mineral-fixed values were generally increasing.

Infrared adsorption patterns were completely dominated by the soil mineral fraction thereby nullifying possible determination of sites or functional groups reactive in NH_3 fixation. An adsorption band peaking near 7μ appeared most closely correlated with mineral-fixed NH_4^+ .

Generally, three-fourths or more of the retained anhydrous NH_3 was KCl leachable. Of the fixed NH_3 (that not leachable with KCl) the major part was associated with the organic fraction except in most subsurface horizons of the recent silty alluvial and water-deposited silt soils wherein the major part was fixed by the mineral fraction.

Comparative $\text{NH}_3/\text{NH}_4^+$ fixation revealed widely variable behavior, suggesting that a considerable gradation of mineral structures may be involved in soil $\text{NH}_3/\text{NH}_4^+$ reactions and that a correspondingly broad range in availability of fixed $\text{NH}_3/\text{NH}_4^+$ is to be expected. A number of the minerals giving significant fixation exhibited characteristics intermediate between specimen montmorillonites and vermiculites, implicating beidellitic and/or expanding vermiculite-like structures.

SWCRD, ARS, USDA, Corvallis, Oreg., 97331

66. Harper, F. R. CONTROL OF ROOT DISEASE IN PEAS BY SEED TREATMENT IN SOUTHERN ALBERTA. Canadian J. Plant Sci. 44(6): 531-537. 1964.

The effectiveness of seven different fungicide treatments on peas (Pisum sativum L.) was determined on irrigated land in southern Alberta from 1961-63. Emergence and yield were higher from treated than from untreated seed. Captan, Semesan, and Bayer 47531 were the most effective fungicides.

The fungicides did not influence either the type or frequency of isolation of pathogens from roots at harvest. Fusarium spp. and Pythium spp. were the fungi most frequently isolated from diseased roots. Pythium was isolated from seeds germinated for 3 days at 15°C . in moist, naturally infested soil, but no pathogens were isolated from seeds treated with captan. Although emergence from untreated seed of six varieties of peas differed with location and variety, emergence from the seed treated

with 65 percent captan was uniformly high. Captan protected both sound and damaged seed from attack by pathogens.

Res. Station, Canada Dept. Agr., Lethbridge, Alberta, Canada.

67. Mitsui, S., Watanabe, I., Honma, M., and Honda, S. THE EFFECT OF PESTICIDES ON THE DENITRIFICATION IN PADDY SOIL. Soil Sci. Plant Nutr. 10(3): 107-115. 1964.

Pot and laboratory experiments were conducted to examine the effect of pesticides and some other compounds on the denitrification in paddy soil. Konosu well drained alluvial paddy soil was used. Pot experiments revealed that Vapam and Dithane (Zineb) depressed the nitrification of urea dressed in soils under upland conditions. However, none of the pesticides examined (Vapam, Dithane, PCP, BHC) exerted a depressive effect on the denitrification of nitrate dressed under water-logged conditions. Vapam showed a remarkable promotion of the mineralization of soil nitrogen.

After preincubation of air dried Konosu soil under anaerobic water-logged conditions in the laboratory, the added nitrate rapidly disappeared, resulting in an approximately stoichiometric accumulation of gaseous products. The process of denitrification was measured by way of nitrate disappearance, nitrite accumulation, and evolution of gas other than CO₂ and O₂.

Among dithiocarbamate compounds, Vapam (20 p.p.m.) remarkably inhibited the denitrification, namely, depressed the denitrification approximately by four tenths. At 100 p.p.m., dithiocarbamates compounds besides Vapam depressed the nitrate disappearance according the following: Ziram < Dithane < Thiuram < Ferbam < Maneb < Nabam. Diethyl dithiocarbamate did not show any depressive action on denitrification. Nabam and Maneb, both alkylidiamine dithiocarbamate compounds, remarkably depressed the denitrification. Zinc salt of ethylene-bisdithiocarbamate (Dithane) depressed the denitrification slightly more than dimethyl dithiocarbamate (Ziram).

Respiratory inhibitors such as azide and monoiodoacetate showed remarkable depression of denitrification. N-Serve (2-chloro, 6-(trichloromethyl) pyridine) at 14 p.p.m. revealed slight inhibition (about 30 percent) of denitrification. The action of PCP (50 p.p.m.), BHC (40 p.p.m.), sodium chlorate (100 p.p.m.) were much less inhibitive. Dicyandiamide at 50 p.p.m. was not inhibitive.

The inhibition of nitrate disappearance was similarly reflected on the inhibition of gas evolution from nitrate. Nitrite was accumulated in proportion to the suppression of nitrate reduction except for azide and N-Serve, that is nitrite reduction is more sensitive to pesticides than nitrate reduction. It was concluded that soil denitrification is not so sensitive to pesticides as is nitrification.

U. Tokyo, Tokyo, Japan.

68. Fox, C. J. S. THE EFFECTS OF FIVE HERBICIDES ON THE NUMBER OF CERTAIN INVERTEBRATE ANIMALS IN GRASSLAND SOIL. Canad. J. Plant Sci. 44(5): 405-409. 1964.

Five herbicides (atrazine, dalapon, nonuron, TCA, and 2,4-D) were applied once to grassland to evaluate their effects for at least two summers after application on the numbers of wireworms, (Agriotes spp.), springtales (Collembola suborder Anthropleona), mites (Acarina), earthworms (Lumbricidae), and millipedes (Diplopoda) in the soil. In plots treated with atrazine, wireworms, earthworms, and springtails declined in numbers. Dalapon increased the numbers of millipedes, springtails, and mites. Monuron reduced the numbers of wireworms, millipedes, earthworms, springtails, and mites. TCA increased the numbers of millipedes, springtails, and mites and decreased the number of earthworms. Treatment with 2,4-D did not affect the numbers of wireworms, springtails, or mites. The data suggest that faunal fluctuations were chiefly caused indirectly by the herbicides altering the floristic composition of the grassland.

Certain herbicides may diminish or increase the numbers of both beneficial and harmful soil animals. Under certain cultural conditions, herbicides as well as insecticides could fit into an integrated control program and help to counter the two threats of insect resistance to insecticides and excessive insecticide residues in soil.

Research Sta., Canada Dept. Agr., Kentville, Nova Scotia, Canada.

Soil-Plant-Animal Relationships

SEE ALSO 32, 35, 36, 37, 96, 99, 114, 117, 119, 123, 126, 127, 128, 129, 134, 143, 144, 145, 151, 198, 206, 215, 255, 267.

69. Allaway, W. H., and Hodgson, J. F. SYMPOSIUM ON NUTRITION, FORAGE AND PASTURES: SELENIUM IN FORAGES AS RELATED TO THE GEOGRAPHIC DISTRIBUTION OF MUSCULAR DYSTROPHY IN LIVESTOCK. J. Animal Sci. 23(1): 271-277. Feb. 1964.

The Se content of forages from different areas in the U.S. was measured and compared with the history of white muscle disease in the region or on the farm where the forage was grown.

The Se content of forages from regions where white muscle disease is fairly common was always less than 0.1 p.p.m. Se.

Within a region where white muscle disease is common, there was no marked difference in the Se content of forages from different farms that could be related to differences in the past incidence of white muscle disease or responses of Se treatment on specific farms.

The forages obtained from the western part of the Cornbelt, a region where white muscle disease is rare, were markedly higher in Se than forages from areas where white muscle disease is common, but the Se contents of these forages from the western Cornbelt region were much lower than recognized toxic levels of Se.

The Se content of the local forages may be an important factor in the broad regional pattern of incidence of muscular dystrophy, or white muscle disease, in livestock.

U.S. Plant, Soil, and Nutr. Lab., SWCRD, ARS, USDA, Ithaca, N.Y., 14850

70. Brooks, O. L. YIELD AND GROWTH RESPONSE OF STUART PECAN TREES TO ZINC SULFATE AND NITROGEN. Ga. Agr. Expt. Sta. C. N. S. 40, 11 pp. 1964.

Application of 1 ton of dolomitic limestone per acre had kept the pH of Norfolk ls near 6.0 for 5 years. Stuart pecan trees made a profitable response in yields to zinc sulfate, where lime was not applied, but where nitrogen, phosphorus, and potassium were not limiting factors. At the same rates of mixed fertilizer, yield response to zinc sulfate averaged about twice as much when limestone was applied as when no lime was applied.

One result of zinc deficiency is the failure of nut shucks to open when the lack of zinc becomes critical. Individual trees, that received all treatments except zinc, produced no marketable nuts after the second year of treatment due to shucks clinging to the nuts.

Leaf drop, starting in early July, was the condition considered most critical for producing a crop of Stuart pecans every year. Applications of mixed fertilizers, limestone, and nitrogen did not retain vigorous leaves later than mid-summer. Healthy, dark green leaves did remain on the trees each year to the date of heavy frost, when zinc sulfate was applied with the other fertilizers.

The lower rates of zinc sulfate gave a yield response equal to the higher rates. The treatment of 10 pounds per tree each 5 years and the other low treatment of 3 pounds per tree per year was adequate for leaf retention and satisfactory yields. It is possible that the 10-pound rate applied during the first year may have contributed more to the higher average yield than the lower annual rate. Initial application, on trees with severe zinc deficiency, should be at rates heavy enough to correct this deficiency.

The greatest response to nitrogen was from the rate of application of 3.35 pounds per tree when added to the 4 pounds of N included in the mixed fertilizer. The rate in mixed fertilizer alone did not give satisfactory yields.

Ga. Agr. Expt. Sta., Athens, Ga.

71. Judy, W., Lessman, G., Rozycka, T., Robertson, L., and Ellis, B. FIELD AND LABORATORY STUDIES WITH ZINC FERTILIZATION OF PEA BEANS. Mich. Agr. Expt. Sta. Q. B. 46(3): 386-395. 1964.

Experiments were conducted in Michigan in 1963 to study the extent of zinc deficient areas, methods of application of zinc, effects of carriers and rates of uptake of zinc, and the interaction of phosphorus on uptake of zinc and yield of pea beans. Zinc deficiencies were severe over tile lines, where large quantities of fertilizer had been used historically, and on alkaline soils. High residual soil phosphate levels reduced the yield of beans unless zinc was included with the starter fertilizer. The use of 3 to 4 pounds of zinc per acre in the inorganic form or approximately one-fifth as much of a chelate form should supply enough zinc on sites where zinc deficiency is known or suspected.

Mich State U., Agr. Expt. Sta., East Lansing, Mich.

72. Ford, E. M. THE CONTROL OF MAGNESIUM DEFICIENCY IN APPLE ROOTSTOCK STOOLBEDS. J. Hort. Sci. 39(3): 212-223. 1964.

Trials lasting 9 years were conducted on two types of magnesium-deficient apple rootstocks to assess the curative value of foliar sprays and/or soil application of Epsom salt ($\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$).

After the first year, M. IV rootstocks sprayed with 2 percent Epsom salt solution produced more, larger, and better-rooted shoots than did the untreated plants, giving more than a 60 percent increase in numbers of high-quality rooted shoots, and three sprayings were as effective as nine.

In contrast to M. IV, spraying MM. 102 rootstocks did not lead to a sustained improvement in quality of rooted shoots even through symptoms of magnesium deficiency were eliminated and the number of shoots increased. Elimination of foliar symptoms was therefore, of itself, no indication of economic improvements of growth. It was concluded that some other factor, perhaps potassium deficiency, limited growth.

Foliar sprays applied nine times annually to M. IV rootstocks raised the percentage of magnesium in the leaves in successive years and eliminated symptoms typical of magnesium deficiency. With only three sprays annually, the magnesium concentration in leaves was also increased, but to a less extent and not until after the second year; the symptoms were reduced in severity but not eliminated. The percentage of potassium in the leaves fell as the percentage of magnesium rose.

Soil applications at the rate of 46 cwt. of Epsom salts per acre spread over 8 years markedly increased "available" magnesium in the top 3 ft. of soil, but produced only small increases in the percentage of magnesium in the leaves. Symptoms were only slightly reduced and there was little increase in growth.

East Malling Res. Sta. Kent, England.

73. Jones, M. B. EFFECTS OF SULFUR ON FIVE ANNUAL GRASSLAND SPECIES. Calif. Agr. 18(2): 4-5. 1964.

In California, sulfur (S) ranks a close third to nitrogen (N) and phosphorus (P) as a major plant nutrient which must be supplied to maintain crop production. While a great many areas of S deficiency are now known through field plot studies, it is important to know the S status of each field so that it can be fertilized properly. One approach is to first determine the minimum $\text{SO}_4\text{-S}$ concentration required in plant tissue for maximum growth of a given crop. A comparison between the $\text{SO}_4\text{-S}$ value obtained from crop samples and that known to be required for good growth indicates the S status of the field.

Differences in yield, sulphate-sulfur ($\text{SO}_4\text{-S}$) concentration, and total sulfur (S) uptake were found among five competing annual grassland species growing at different levels of available S at Hopland. Yield response of subclover, soft chess, and ripgut to S fertilization increased as the season advanced, but the concentration of total S and $\text{SO}_4\text{-S}$ in the plants decreased. Sulfur deficiency was indicated by the $\text{SO}_4\text{-S}$ concentration in each of the species where no S had been applied. The $\text{SO}_4\text{-S}$ concentration in subclover at flowering gave the best single indication of S status when all levels of available S were considered. Where no S was applied, there was little or no uptake of S after the first harvest date, but where S was applied, it continued to be absorbed by subclover, soft chess, and ripgut up to the third harvest. The increase over the check was much greater for subclover than for any of the other species.

U. Calif., Hopland Field Sta., Hopland, Calif.

74. Rieke, P. E., and Davis, J. F. BORAX TOXICITY IN WHITE PEA BEANS. Mich. Agr. Expt. Sta. Q. B. 46(3): 401-406. 1964.

Pea beans were planted in rows running in the opposite direction to bands of borax fertilizer to determine the initial and residual effects. Borax application did not affect the germination of the seed, but many plants that emerged near the borax band died within 3 weeks. As the application rate of borax was increased, fresh weights of plants decreased. Later planting dates also decreased plant weights. There was a significant interaction between rate of application and planting date on green plant weight.

Mich. State U., Agr. Expt. Sta., East Lansing, Mich.

75. Allred, S. E., and Ohlrogee, A. J. PRINCIPLES OF NUTRIENT UPTAKE FROM FERTILIZER BANDS. VI. GERMINATION AND EMERGENCE OF CORN AS AFFECTED BY AMMONIA AND AMMONIUM PHOSPHATE. Agron. J. 56(3): 309-313. 1964.

Laboratory experiments were conducted to determine the effect of free ammonia and free ammonia associated with ammonium phosphates on the germination and emergence of corn.

Ammonia over NH_4OH solutions in desiccators at partial pressures as low as 0.125 mm. Hg was toxic to corn exposed to this environment in the initial stage of germination for only 2 days. It was toxic at lower levels when the exposure time was increased.

Emergence of corn seed, planted 2 inches deep in coarse quartz in closed (with 2 mil. polyethylene) test tubes was used to study the effects of MP and DP solutions. It was concluded that free ammonia derived from the hydrolyzable secondary ammonia radical of DP was apparently toxic to corn. In a similar experiment, CaCO_3 accentuated the deleterious effect on corn of both MP and DP solutions.

Corn was germinated in fine sand and silt loam soils in closed rectangular glass vessels at various geometric positions with respect to MP and DP bands (1 g./in.). The deleterious effect of DP on corn root development was more pronounced than the effect of equal amounts of MP.

Using a closed 6-inch cubical cell in which perforated plastic tubes were fixed, measurements of ammonia movement in soil material with time around a DP band (1 g./in.) were made. Free ammonia associated with the DP bands rapidly permeated the soil pore space to distances as great as 3 inches from the band.

TVA, Wilson Dam, Ala.

76. Hood, J. T., and Enslinger, L. E. THE EFFECT OF AMMONIUM PHOSPHATE AND OTHER CHEMICALS ON THE GERMINATION OF COTTON AND WHEAT SEEDS. Soil Sci. Soc. Amer. Proc. 28(2): 251-253. 1964.

Field greenhouse studies with cotton and wheat showed that fertilizers containing ammonium phosphates were especially detrimental to germination and could result in very poor stands. Seeds were soaked in salt solutions (including ammonium phosphates) and acids for various time intervals to study this effect. The seed surfaces were then washed free of the solutions and allowed to germinate. The $(\text{NH}_4)_2\text{HPO}_4$ solutions reduced germination more than any other salt solution including $\text{NH}_4\text{H}_2\text{PO}_4$. In studies with cotton seed, a solution of $(\text{NH}_4)_2\text{SO}_4$ adjusted with NH_4OH to pH 8.2 did not reduce germination as much as did $(\text{NH}_4)_2\text{HPO}_4$. Germination was lowered more by H_2SO_4 than by H_3PO_4 at the same pH. Soaking the seed in salt solutions such as CaSO_4 before soaking in $(\text{NH}_4)_2\text{HPO}_4$ did not improve germination. When the seeds were soaked in MgSO_4 or MgCl_2 after being soaked in $(\text{NH}_4)_2\text{HPO}_4$, there was an improvement in germination as compared with $(\text{NH}_4)_2\text{HPO}_4$ alone. Soaking in MgSO_4 and MgCl_2 did not increase the germination of seed that had been soaked in H_3PO_4 .

The detrimental effect from diammonium phosphate was not one of osmotic effect alone, since other salts did not reduce germination as much as did diammonium phosphate. Even ammonium and phosphate salts did not reduce germination as much as diammonium phosphate. Thus, it is apparently not the ammonium or phosphate ion per se that lowers germination. Phosphoric acid reduced germination probably as a result of high acidity. The $(\text{NH}_4)_2\text{SO}_4$ solution adjusted with NH_4OH to the same pH as the $(\text{NH}_4)_2\text{HPO}_4$ solution did not reduce germination as much as $(\text{NH}_4)_2\text{HPO}_4$. Thus the detrimental effect was apparently not due to ammonia alone. The corrective effect obtained from MgSO_4 and MgCl_2 suggests that $(\text{NH}_4)_2\text{HPO}_4$ may be adversely affecting Mg utilization in the seed, possibly through interference with enzymatic activity.

Agr. Expt. Sta., Auburn U., Auburn, Ala.

77. Miller, G. D., Deyoe, C. W., Walter, T. L., and Smith, F. W. VARIATIONS IN PROTEIN LEVELS IN KANSAS SORGHUM GRAIN. Agron. J. 56(3): 302-304. 1964.

Results of protein analyses of grain sorghum samples collected in 1958, 1961, and 1962 were reported. Wide variation in protein content existed, with ranges from 6.6 to 12.8 percent in 1961 and from 5.9 to 12.1 percent in 1962. Significant differences due to location and varieties or hybrids were found. The results of fertilizer tests showed that both protein content and yields could be increased by nitrogen fertilization.

Kans. State U., Manhattan, Kans.

78. Bedrak, E., Warnick, A. C., Hentges, J. F., Jr., and Cunha, T. J. EFFECT OF PROTEIN INTAKE ON GAINS, REPRODUCTION, AND BLOOD CONSTITUENTS OF BEEF HEIFERS. Fla. Agr. Expt. Sta. Tech. B. 678, 30 pp. 1964.

Twenty yearling Angus, Hereford, and Angus-Hereford crossbred heifers and 20 2-year-old Hereford heifers were individually fed rations consisting of different levels of protein but similar amounts of energy, minerals, and vitamins. Five heifers of each age were allotted per group and fed for a period of 159 to 207 days, depending on reproduction performance.

Yearling heifers, initially weighing about 500 pounds, with a daily consumption of 1.06, 0.65, 0.28, and 0.08 pound crude protein, gained 0.94, 0.70, 0.01, and -0.72 pound per day, respectively. Two-year-old heifers, initially weighing 675 pounds, consuming 1.34, 1.06, 0.71, and 0.62 pound crude protein daily, gained 0.75, 0.52, -0.07, and -0.23 pound per day, respectively. The differences obtained in the performance between the yearling and 2-year-old heifers were due in part to age and weight differences, as well as source of energy and level of TDN and protein intake. The nutritional stress due to a low protein intake decreased appetite and rate of gain.

At 44 days post-breeding, there were 10 normal embryos from 10 yearling heifers fed the two highest levels of protein, while there were no normal embryos from the 10 heifers on the two lower levels of protein. Eight of these latter heifers did not ovulate. Yearling heifers that consumed 0.28 pound crude protein daily or less exhibited delayed puberty, long anestrus periods, failure to show estrus and ovulate, and weak expression of estrus.

Two-year-old heifers on the two higher intakes of protein had seven normal embryos from 10 heifers bred, while there were only four normal embryos from seven heifers bred that were on the lower protein intakes. Three of the five 2-year-old heifers fed 0.71 pound crude protein daily ovulated without showing estrus and could not be bred.

The daily protein need for yearling beef heifers weighing 500 pounds with daily gains of 0.70 pound was met by feeding 0.65 pound crude protein daily. A level of 1.06 pound crude protein daily was required to achieve a somewhat similar gain of 0.75 pound daily with 2-year-old heifers weighing 675 pounds.

U. Fla., Agr. Expt. Sta., Gainesville, Fla.

79. Chapman, H. D. FOLIAR SAMPLING FOR DETERMINING THE NUTRIENT STATUS OF CROPS. World Crops. 16(3): 36-46. Sept. 1964.

Widely varying sampling techniques have been, and continue to be, used for determining the nutrient status of plants. While with some crops there is some trend towards standardization, much of the data is not directly comparable because of variable techniques employed. Standard sampling and handling techniques for a considerable number of agriculturally important crops were suggested so that further testing, refinement, and development of foliar diagnostic criteria can be exploited.

The plant part to sample, the age at which to sample, the number of plants, and sampling pattern were suggested. References supporting the recommendations were given.

Crops covered were: Alfalfa; almond; apple; apricot; asparagus; avocado; banana; barley; bean; beet; sugar beet; boysenberry; Brussels sprouts; cabbage; cacao; carrot; cauliflower; celery; cereals; cherry; clovers; coffee; corn; cotton; currants; grape; grasses; lemon; lettuce; lime; magnolia; mango; millet; oats; olive; orange; palm; pea; peach; peanut; pear; pecan; pineapple; plum; potato; raspberry; rice; rubber; rye; sorghum; soybean; strawberry; sugar cane; tea; tomato; tung; walnut; and wheat.

U. Calif., Riverside, Calif.

80. Beaton, J. D., Kosick, R., and Speer, R. C. CHEMICAL COMPOSITION OF FOLIAGE FROM FERTILIZED PLUS DOUGLAS FIR TREES AND ADJACENT UNFERTILIZED CHECK TREES. Soil Sci. Soc. Amer. Proc. 28(3): 445-449. 1964.

Shoots of the 1960, 1961, and 1962 growth were removed from two fertilized plus trees and two unfertilized adjacent check trees in April 1963. Each plus tree received 80 pounds of 16-20-0 ammonium phosphate sulphate fertilizer in April 1961, and 40 pounds of the same fertilizer in April 1962. The length of the shoots was measured and needle production was determined. Needles from each of the 3 years of growth were analyzed for N, P, K, Ca, Mg, and S.

Fertilization increased the length of the 1962 shoots. Diameter of the shoots also appeared to be increased. Needles from the fertilized trees seemed to be larger and darker green in color. Weight of needles produced in 1962 was greatly increased by fertilization. Concentration and weight of N in needles was markedly increased by fertilization, particularly in the 1962 growth. Phosphorus concentration was slightly reduced by fertilization. However, the weight of P in the 1962 needles was increased by fertilization. The N/P ratios in all needle samples from the fertilized trees were much greater than those in the unfertilized check trees. Although K concentration was reduced in the foliage from fertilized trees, weight of K was not influenced by fertilization. Potassium percentage tended to be lowest in the oldest tissue, and highest in the youngest tissue of all trees. Concentration and weight of Ca was highest in foliage from the fertilized trees. Calcium concentration increased with age of all foliage samples. Fertilization resulted in an increase in concentration and weight of Mg. Concentration and weight of S was highest in the foliage from fertilized trees. Older needles appeared to have a higher S concentration than the younger needles.

Res. and Develop. Div., Consolidated Mining and Smelting Co. Canada Ltd. Trail, British Columbia, Canada.

81. McEvoy, E. T. VARIETAL DIFFERENCES IN PHOSPHORUS LEVEL IN LEAVES OF FLUE-CURED TOBACCO. Canad. J. Plant Sci. 44(3): 263-264. 1964.

Six varieties of flue-cured tobacco were tested in the greenhouse in soil for differences in phosphorus level in the leaves, using radiophosphorus. Radioactivity measurement of leaf samples showed significant varietal differences of P-32 activity in the leaves. The level of P-32 per sq. cm. of leaf tissue was higher in Delcrest, Hicks, and Virginia Gold than in White Gold, Jadel, and White Mammoth.

Plant Res. Inst., Canada Dept. Agr., Ottawa, Alberta, Canada.

82. Baker, D. E., Thomas, W. I., and Gorsline, G. W. DIFFERENTIAL ACCUMULATION OF STRONTIUM, CALCIUM, AND OTHER ELEMENTS BY CORN (ZEA MAYS L.) UNDER GREENHOUSE AND FIELD CONDITIONS. Agron. J. 56(3): 352-355. 1964.

During the summer of 1962, five selected single-cross corn hybrids were grown under both greenhouse and field conditions to determine the effect of gross changes in environment on differential accumulation of ions. Analysis of variance data and correlations indicated that the hybrids accumulated different amounts of Sr, Ca, Mg, K, P, Mn, Fe, B, and Zn under both environments. The accumulations of Cu and Al were not significantly different for the five hybrids.

The authors concluded that: (1) Differential accumulation of elements by mature corn hybrids grown in the field can be predicted from the results for young plants of the same hybrids grown on a uniform substrate and be at the same stage of development when leaves or whole plants are removed for analysis; (2) all hybrids must be grown on a uniform substrate and be at the same stage of development when leaves or whole plants are removed for analysis; (3) ear leaves collected from hybrids in the field at about

30 days post silk provided an adequate estimate of whole plant accumulations of Sr, Ca, Mg, and P, but possibly not for K; and (4) hybrids which accumulate relatively large or small concentrations of one ion do not accumulate all ions in the same relative manner. This last observation indicates that differential accumulation results from independent mechanisms which are under different genetic control.

Pa. State U., Col. Agr., Agr. Expt. Sta., University Park, Pa.

83. MacLaren, R. B., and Sterling, J. D. E. A GREENHOUSE STUDY OF THE EFFECT OF NITROGEN, PHOSPHORUS, AND POTASSIUM ON BRITTLINESS AND ASH CONTENT OF BARLEY AWNS. *Canad. J. Plant Sci.* 44(3): 268-271. 1964.

The influence of four levels of each of nitrogen, phosphorus, and potassium on the brittleness and ash content of barley awns was investigated. Awns were significantly more brittle at higher levels of N and P but significantly less brittle at higher levels of K. Ash content was not affected by changes in N level but was significantly higher with higher levels of P and significantly lower with higher levels of K.

Expt. Farm, Canada Dept. Agr., Charlottetown, Prince Edward Island, Canada.

84. Power, J. F., Grunes, D. L., Reichman, G. A., and Willis, W. O. SOIL TEMPERATURE AND PHOSPHORUS EFFECTS UPON NUTRIENT ABSORPTION BY BARLEY. *Agron. J.* 56(3): 355-359. 1964.

The effects of soil temperature and P supply upon N and P concentration and absorption by barley were studied in a growth chamber. Total N and P concentration were generally inversely proportional to dry matter production, reaching a maximum at soil temperatures near 59° F. Increasing the P supply, by either increasing the soluble soil P supply or by P fertilization, generally increased P concentrations in the plant material.

Total N and P absorption from P fertilizer soil was maximum at soil temperatures in the 52 to 66° F. range. A soil temperature of 73° F. gave highest N and P absorption from soils receiving no P fertilizer. On both soils, soil temperature had a greater influence on fertilizer P absorption than on soil P absorption. Soil P absorption was greater from the medium P soil than from the low P soil. P fertilization reduced soil P absorption only at the warmer soil temperatures.

At low soil temperatures, dry matter production increased only slightly with increasing P concentrations in the plant tissue. At above optimum temperatures, P concentrations were quite high, but a small increase in percent P resulted in a large increase in dry matter production. The value of the "critical level" for P was lowest and dry weight per unit P in the plant was highest, at the 59° F. soil temperature. The curves relating dry weight to percent P in the plants diverged with increasing P content for soil temperatures below 59° F., whereas at higher temperatures these curves tended to converge at high P concentrations. This indicates that the mechanisms limiting growth at below-optimum soil temperatures may be quite different from those active at above-optimum soil temperatures.

USDA Northern Great Plains Research Center, SWCRD, ARS, USDA, Mandan, N. Dak., 58554

85. Chaudhry, M. S., McLean, E. O., and Franklin, R. E., Jr. EFFECTS OF NITROGEN, CALCIUM: POTASSIUM SATURATION RATIO, AND ELECTROLYTIC CONCENTRATION ON UPTAKE OF CALCIUM AND POTASSIUM BY RICE PLANTS. Agron. J. 56(3): 304-307. 1964.

Rice plants were grown in a growth chamber under different nitrogen treatments, calcium:potassium saturation ratios of the soil exchange complex, and electrolyte (CaCl_2) concentrations. Both short term (4-day) and long term (40-day) studies were made to investigate the effects of the various factors on Ca and K uptake by rice using CA-45 and RB-86 as tracers.

Root cation exchange capacities of the rice seedlings were increased by N treatment, but the differences disappeared during the longer growth period; and only relatively small effects of the N treatment were evident on Ca and K uptake. The amounts of Ca and K taken up increased with saturation of each cation and with level of electrolyte present. Arithmetic increases in Ca saturation generally caused geometric increases in Ca uptake. The marked increases in uptake of Ca when relatively small increases in concentration of CaCl_2 were made appeared to emphasize the competitive role of soil colloids for the Ca and the importance of free (active) Ca in Ca uptake. Smaller effects of electrolyte concentration on K than Ca uptake evidently resulted from relatively strong bonding of K at low K saturations and relatively weak bonding compared to Ca at higher K saturations.

The uptake of Ca was relatively high in the short term study and remained so with time while the uptake of K was low initially and increased with time. The data indicate that a portion of the K was bonded very strongly, and thus became available to the rice plants only as the K saturation was increased or as increased root growth brought the plant in contact with more soil.

The trends in amounts of Ca taken up from the soil according to cation saturation and electrolyte level were rather similar in the 4-day and 40-day uptake periods. Less similarities were evident in uptake of K in the two uptake periods.

Sufficient saturation of the soil cation exchange capacity with K was essential for adequate uptake of K, but greater than 10 percent of the cation exchange capacity of soil was detrimental to Ca uptake. A higher concentration of electrolyte than 0.02 S (electrolytic concentration) was beneficial to uptake of Ca by rice plants.

Jr. Author, Ohio State U., Agr. Expt. Sta., Columbus, Ohio.

86. Jasmin, J. J., Heeney, H. B., and Turchot, R. POTASSIUM AND PHOSPHORUS ACCUMULATION IN ORGANIC SOIL AND THEIR INFLUENCE ON POTATO CROPS. Canad. J. Soil Sci. 44(3): 280-285. 1964.

Repeated application of fertilizer over a 5-year period (1957-61) on organic soil producing potatoes resulted in large increases in exchangeable potassium and in moderate increases in acid-soluble plus absorbed phosphorus. Where potatoes were grown without application of fertilizer, the exchangeable potassium decreased rapidly but the available phosphorus remained at a constant level.

Fertilizer treatments influenced yields only in 1961, and percent total N and P in leaf tissue only in 1961 and 1958, respectively. In all years, the percent total potassium in leaf tissue was in direct relation to rate of fertilizer applied and the percentage of Ca and Mg generally decreased as percent potassium increased. The specific gravity and the general boiling quality of the tubers were adversely affected by heavy fertilization, but the chipping quality, the flavor, and the color of the flesh were not affected by soil fertility differences.

Res. Sta., Canada Dept. Agr., St. Jean, Quebec, Canada.

87. Rumburg, C. B., Wallace, J. D., and Raleigh, R. J. INFLUENCE OF NITROGEN ON SEASONAL PRODUCTION OF DRY-MATTER AND NITROGEN ACCUMULATION FROM MEADOWS. Agron. J. 56(3): 283-286. 1964.

The influence of N fertilizer on seasonal production of dry-matter and N accumulation in herbage from native meadows was studied in 1960-61 in Oregon.

Increasing levels of N fertilizer increased yields and extended the period of production later into the growing season.

During early stages of growth, the internal concentration of N increased with increasing levels of N application. However, the N concentration was continuously diluted by an increase in dry matter until the time of maximum yield. The rate of dilution increased with increasing levels of applied N. As a result, the N concentration in the herbage was about the same after June 21 at all levels of N. Actually, the N content was lower in herbage from fertilized plots than from unfertilized plots late in the season.

The herbage continued to accumulate N until 1 week before the time of maximum dry-matter production. After reaching a peak, N was actually lost in that it was not accounted for in the herbage. The loss of N increased with increasing levels of N fertilizer. N recovery values depend upon the time of harvest relative to the stage of maturity. Yields of regrowth decreased sharply with each week's delay in harvest of the initial crop. However, N concentration in regrowth herbage increased with delayed harvest of the initial crop (when the regrowth was in an early stage of development).

CRD, ARS, USDA, Squaw Butte Expt. Sta., Burns, Oreg.

88. Pritchard, G. I., Pigden, W. J., and Folkins, L. P. DISTRIBUTION OF POTASSIUM, CALCIUM, MAGNESIUM, AND SODIUM IN GRASSES AT PROGRESSIVE STAGES OF MATURITY. Canad. J. Plant Sci. 44(4): 318-324. 1964.

Distribution of potassium (K), calcium (Ca), and magnesium (Mg) in timothy and brome grass cut at eight progressive dates was similar in both grasses. Highest concentrations were usually found in leaves, lowest at the base of stems, with levels in stems increasing toward the center or tips. With progressive maturity, K, Ca, and Mg content of stems decreased whereas in leaves and heads, K decreased, Ca increased, and Mg remained relatively constant. Sodium (Na) showed little change with progressive cutting dates but low concentrations of this element suggested an inadequate supply in the soil to permit deposition in the plant.

In both grasses, ratios of K/Ca, K/Mg, and K/(Mg+Ca), were large. These ratios stayed relatively constant in leaves throughout the season but decreased in heads and stems with progressive cuttings. The Ca/Mg ratio tended to be higher in stems than in heads.

Animal Res. Inst., Canada Dept. Agr., Ottawa, Canada.

89. Leaf, A. L. PURE MAPLE SYRUP: NUTRITIVE VALUE. Sci. 143(3609): 963-964. 1964.

Variations in concentrations of sugar, nitrogen, phosphorus, potassium, calcium, and magnesium of sap from sugar maple (Acer saccharum, Marsh.) trees were related to the time of sap collection and result in variation of the same components in pure

maple syrup. Thirty milliliters (one fluid ounce) of pure maple syrup may contain 3 to 6 mg of phosphorus, 10 to 30 mg of potassium, 40 to 80 mg of calcium, and 4 to 25 mg of magnesium.

Table Average yields of sap, and average sugar and nutrient element concentrations (volume basis) of sap and syrup during the 1960 tapping season of four sugar maple trees in central New York.

Sap yield per tap-hole (lit.)	Sap sugar conc. (%)	Sap syrup (v/v)	N (%)		P (ppm)		K (ppm)		Ca (ppm)		Mg (ppm)	
			Sap	Syrup	Sap	Syrup	Sap	Syrup	Sap	Syrup	Sap	Syrup
5.0	3.6	24/1	0.72	0.010	3.3	79.2	10.0	240.0	49.0	1176.0	5.0	120.0
9.7	3.5	25/1	0.78		3.3	82.5	12.5	312.5	54.0	1350.0	9.8	245.0
7.4	4.7	18/1	1.35		3.8	68.4	20.0	360.0	81.0	1458.0	21.0	375.0
9.1	3.7	23/1	2.16		3.5	80.5	19.3	443.9	86.0	1978.0	22.0	506.0
7.3	3.3	26/1	2.06		3.4	88.4	12.0	312.0	96.0	2496.0	28.0	728.0
Trace	3.2	27/1	3.96	0.054	6.8	183.6	36.0	972.0	76.0	2052.0	17.0	459.0

Dept. Silviculture, State U. Col. Forestry, Syracuse U., Syracuse, N.Y.

90. Sasaki, S. UPTAKE OF CALCIUM AND MAGNESIUM BY BUCKWHEAT FROM LIMESTONE. Soil Sci. Plant Nutr. 10(3): 99-106. 1964.

The uptake of calcium from different limestones was investigated by using buckwheat as the test plant in a greenhouse. The results were as follows:

1. Larger amounts of calcium were absorbed by buckwheat from calcite than from dolomite limestone (identical degree of fineness).
2. Increased applications of calcite had a slight tendency to reduce absorption of magnesium by buckwheat.
3. Dolomite limestone applications increased magnesium uptake; however, calcium uptake was not greatly increased.
4. A magnesium limestone (7.11 percent MgO) and a 50/50 mixture of calcite and dolomite limestone gave calcium and magnesium uptake similar to the calcite limestone (all with identical degrees of fineness).
5. The dolomite limestone was about 60 percent as effective as the calcite limestone in regard to change in soil pH.
6. Considering calcium and magnesium uptake and change in soil acidity, the magnesium limestone was potentially the most satisfactory liming material of those tested.

Hokkaido U., Hokkaido, Japan.

91. Hall, I. V., Aalders, L. E., and Townsend, L. R. THE EFFECTS OF SOIL pH ON THE MINERAL COMPOSITION AND GROWTH OF THE LOWBUSH BLUEBERRY. *Canad. J. Plant Sci.* 44(5): 433-438. 1964.

A greenhouse study of lowbush blueberries using five clonal lines, four different growth media (soil, soil plus sawdust, greenhouse potting compost, and greenhouse seed compost) and various pH levels (from 4.2 to 6.9) showed that growth was affected by additions of dolomitic limestone. Optimum growth occurred at the lowest pH levels (4.2, 4.9, and 5.0) for three of the media and for the seed compost at intermediate levels (4.9 and 5.5). Nutrient uptake, foliar nutrient levels, and pH were closely associated with growth. Although some clones grew more than others, the pattern of response to the applications of limestone was similar for all clones.

Research Sta., Canada Dept. Agr., Kentville, Nova Scotia, Canada.

92. McEnroe, P., and Coulter, B. EFFECT OF SOIL pH ON SUGAR CONTENT AND YIELD OF SUGAR BEET. *Irish J. Agr. Res.* 3(1): 63-69. 1964.

A survey was carried out on 3,020 farms to determine the effect of soil pH on sugar content and yield of sugar beet. As the soil pH increased from below 6.0 to above 7.0, the sugar content increased from 15.2 to 15.8 percent and the sugar yield from 34.2 to 39.3 cwt. per acre. The optimum pH was above 7.0, but only 34 percent of the farms sampled were in this category.

TABLE - Relationship between soil pH and mean sugar content and yield

pH	Mean sugar content, percent	Mean sugar yield, cwt. per acre
4.5-5.9	15.2	34.2
6.0-6.5	15.4	34.6
6.6-7.0	15.6	37.6
>7.0	15.8	39.3

An Foras Taluntais (The Agricultural Institute), Soils Div., Johnstown Castle, Wexford, Ireland.

Soil Classification

SEE ALSO 2, 21, 31, 54, 55, 57, 58, 59, 60, 62, 65, 67, 70, 75, 86, 91, 98, 100, 102, 103, 106, 107, 108, 113, 115, 119, 120, 122, 124, 127, 135, 136, 143, 148, 149, 150, 156, 157, 163, 164, 220, 221, 225.

93. Murray, R. C. ORIGIN AND DIAGENESIS OF GYPSUM AND ANHYDRITE. *J. Sedimentary Petrology.* 34(3): 512-523. 1964.

Despite data on the stability of anhydrite at high earth surface temperatures, the observation of recent gypsum and the evidence for formation and preservation of metastable gypsum suggest that this form may be the common if not universal original calcium sulfate mineral. Gypsum beds can be produced by two mechanisms: (1) Precipitation and sedimentation in a standing body of water subjected to evaporation. Such deposits are original sedimentary facies, contemporaneous with other sedimentary facies. And (2) growth of abundant crystals by displacement of unconsolidated sediment or

weathered rocks, which results in beds of gypsum which later is replaced by nodular anhydrite. These nodular anhydrite beds represent a diagenetic facies and postdate the host material. The distinction between sedimented and nodular is important in the interpretation of any given evaporite deposit.

These primary deposits act as a source of calcium sulfate for subsurface growth of replacement and voidfilling anhydrite. The latter two secondary type of anhydrite can be distinguished in reflected light, since a dark color is imparted to replacement anhydrite by included material.

From observations in recent sediments, older outcrops, and the subsurface, there appears to be a characteristic cycle in the diagenesis of gypsum-anhydrite minerals: Surface or near-surface gypsum is replaced by anhydrite as a result of burial and is in turn replaced by gypsum if the anhydrite is thereafter brought close to the surface.

Shell Develop. Co., Houston, Tex.

94. Taylor, H. M., Mathers, A. C., and Lotspeich, F. B. PANS IN THE SOUTHERN GREAT PLAINS SOILS: I. WHY ROOT-RESTRICTING PANS OCCUR. Agron. J. 56(3): 328-332. 1964.

Seventeen root-restricting pans of the Southern Great Plains were investigated. The concept that soil pans are either genetic in origin or that they develop as a result of man's manipulation of the soil can explain less than half of the cases. The theory was developed that the root-restricting features of these 17 pans were caused by excessive soil strength that occurs largely as a result of soil drying.

Southern Great Plains Field Sta., SWCRD, ARS, USDA, Bushland, Tex., 79012

95. McDonald, J. E., Steedly, W. M., and Lesesne, F. F. SOIL RESOURCES FOR AN EXPANDING POPULATION: JAMES ISLAND, CHARLESTON COUNTY, SOUTH CAROLINA. Unnumbered Report of U.S. Dept. Agr., Soil Conserv. Serv. in Coop. with S.C. Agr. Expt. Sta. 37 pp. and maps. 1963.

Chemical and physical classification of the soils on James Island, Charleston County, S.C., were given along with recommendations for their use for agriculture, residences, recreation, commerce, transportation, and wildlife.

Soil profile descriptions, tables, and maps.

Charleston Soil Conserv. Dist., Charleston, S.C.

96. Krogman, K. K., and Lutwick, L. E. UPTAKE OF NITROGEN BY WHEAT, AND PHOSPHORUS BY ALFALFA, FROM SOME GRASSLAND SOILS OF SOUTHERN ALBERTA. Canad. J. Soil Sci. 44(3): 304-309. 1964.

The uptake of nitrogen by wheat and of phosphorus by alfalfa grown in the greenhouse on 16 A-horizon soils was correlated with the soils separated according to the Canadian soil classification system. Uptakes of both elements were greater from the Chernozemic than from the Solonetzic soils. Within the Solonetzic Order, uptakes were greater from the Solodized-Solonetz than from the Solod soils. Within the Chernozemic Order, nitrogen uptake was greater from the Black soils than from the Brown or Dark Brown soils, whereas phosphorus uptake was greater from the Dark Brown soils than from the Black or Brown soils. Phosphorus uptake and response to phosphorus fertilizer were closely correlated with NaHCO_3 -extractable soil phosphorus.

Res. Sta., Canada Dept. Agr., Lethbridge, Alberta, Canada.

EROSION CONTROL

Wind and Water Erosion

SEE ALSO 4, 27, 102, 107, 187.

97. Armbrust, D. V., Chepil, W. S., and Siddoway, F. H. EFFECTS OF RIDGES ON EROSION OF SOIL BY WIND. Soil Sci. Soc. Amer. Proc. 28(4): 557-560. 1964.

The effect of ridges on soil erosion by wind was studied under laboratory conditions with wind tunnels. Smoothed soil surface and 1.3, 2.5, 10.2, and 20.3 cm. high ridges constructed of dune sand and three simulated cultivated soils were exposed to six wind velocities ranging from 47 to 83 miles per hour. Ridges 5.1 to 10.2 cm. high eroded little due to trapping of soil particles between ridges and average wind velocity decrease. Ridges less than 5.1 cm. high were not as effective in trapping soil particles and reducing wind velocities. Extensive erosion on ridges higher than 10.2 cm. resulted from higher wind velocities at the ridge crests and increased wind eddying.

SWCRD, ARS, USDA, Big Springs, Tex., 79721

98. Schmidt, B. L., Shrader, W. D., and Moldenhauer, W. C. RELATIVE ERODIBILITY OF THREE LOESS-DERIVED SOILS IN SOUTHWESTERN IOWA. Soil Sci. Soc. Amer. Proc. 28(4): 570-574. 1964.

Measurements of original and present surface soil depth, as indicated by slope and erosion field data and organic carbon contents, were used to determine the relative erodibility of the loess-derived Monona, Marshall, and Sharpsburg soils in southwestern Iowa. Decreasing surface soil depths with increasing slope were reported on all three soils, with the Monona soil having the least and Sharpsburg the most surface soil remaining. The difference in average depth to an arbitrary benchmark, 0.90 percent organic carbon content, in cultivated as compared with virgin profiles of each soil indicated, however, that slightly lower erosion losses due to cultivation over time have occurred on the Monona soil.

Laboratory rainfall simulator studies indicated higher infiltration and lower soil loss rates on the Monona soil than on the Marshall and Sharpsburg soils. The formation of a dense surface seal by raindrop impact appeared to be a dominant factor in the erodibility of these soils. Studies on crusted samples indicated slightly lower soil loss and higher infiltration rates on the Monona even with the crust present.

Ohio Agr. Expt. Sta., Wooster, Ohio.

Critical Areas

99. Riley, C. V. REVEGATION AND MANAGEMENT OF CRITICAL STIES FOR WILDLIFE. 28th North Amer. Wildlife and Natl. Resources Conf. Trans.: 269-283. 1963.

Surface mining for coal had affected approximately 690,000 acres of land in Illinois, Indiana, Kentucky, Ohio, Pennsylvania, Tennessee, and West Virginia by 1961. The strip lands, after mining operations are completed, are generally reclaimed for forestry or grazing. By modifying present reclamation concepts and by instituting basic wildlife management principles and practices, the reclaimed strip lands can be made more productive for wildlife.

Data resulting from the analyses of 78 composite soil samples, from experimental strip land plots in Ohio, indicated the presence of certain factors which could be toxic or limiting to plant survival and growth. Soil reaction, was extremely acid to

slightly alkaline. The pH values for spoil in which various plant species were field tested ranged from 2.7 to 8.2. Sulfates (SO_4) ranged from 10 to 626 pounds and total soluble salts 40 to 9,000 pounds per acre. Relatively high concentrations of aluminum, copper, iron, manganese, molybdenum, and zinc were present in some samples. Deficiencies of nitrogen, phosphorus, and potash were indicated.

Compaction of the surface soil decreased the rate of water infiltration on certain spoil types and adversely affected the establishment of vegetation by seeding.

A total of 85 plant species were field tested on 107 strip land plots in southeastern Ohio. Plots were located on selected spoil types having critical site factors. Of the various trees, shrubs, grasses, and legumes tested under field conditions, 57 species were rated as being successful on the specific soil conditions. The successful plant species grew on soil having a range of pH values from 3.4 to 7.2. Many species of shrubs, grasses, and legumes displayed a tolerance to very acid soils, high concentrations of trace elements, sulfates, and soluble salts.

Management techniques that appeared to be both economically feasible and practical for enhancing the habitat for wildlife included the development of strips of vegetation by the use of the bulldozer. The areas within the forest communities were seeded to grasses and legumes such as *Sericea lespedeza*, crown vetch, birdsfoot trefoil, alfalfa, timothy, orchard, and smooth brome grass while the shrubby species such as bicolor *Sericea* and Japan *lespedeza* were used to produce strips within the pasture lands. Additional techniques included increasing the normal tree spacing standards to 14 feet and seeding the spoil surface to grasses and legumes. Trees, normally spaced, were also planted in narrow strips with seedlings of grasses and legumes located between the tree strips. Mowing lanes within established pastures, in late summer and autumn, resulted in the production of more palatable vegetation as well as more satisfactory conditions for hunting.

Kent State U., Kent, Ohio.

100. Bishop, D. M., and Stevens, M. E. LANDSLIDES ON LOGGED AREAS IN SOUTHEAST ALASKA. U.S. Forest Serv. Res. Paper NOR-1, 18 pp. 1964.

Recent large-scale clearcut logging of timber in southeast Alaska has accelerated debris avalanches and flows on steep slopes during heavy rainfall. Characteristics and possible mechanisms for these disturbances include:

1. Flows are more frequent within the V-notch side-drainages than on the smoother glacial valley walls. This was attributed to V-notch channel down-cutting producing oversteepened slopes.
2. Flows or avalanches usually slide on relatively smooth, wet planes oriented parallel to the slope when this plane is composed of such materials as glacial till, iron-organic layered material, metamorphosed sediments, or diorite.
3. Limited evidence leads to the assumption that southeast Alaskan flow-prone soils are usually cohesionless.
4. A greater addition of water weight to the soil mantle through rainfall is not a likely stimulus for increased flows after logging.
5. Weight loss by timber removal probably has no direct net effect on the likelihood of shearing since decrease of shear stress with unloading is equal to shear strength reduction.
6. Loss of timber weight may reduce shear strength in soil immediately under the tree root systems.
7. Loss of root systems as a strength builder-maintainer in the soil mantle may be an important factor in accelerating flows after logging.

8. Debris in the bottoms of steep ravines aggravates stability conditions. Logs and stumps on side slopes contribute to such instability by rolling or sliding into the channel.
9. Slopes of 34° (67 percent) or more are highly susceptible to failure when conventional downhill highlead logging is used.

Tables and photographs.

Northern Forest Expt. Sta., FS, USDA, Juneau, Alaska.

SOIL MANAGEMENT

Cropping Practices

SEE ALSO 26, 27, 30, 32, 57, 62, 101, 111, 120, 147, 152, 155, 194, 195, 201, 202, 213, 226.

101. Brown, P. L. LEGUMES AND GRASSES: IN DRYLAND CROPPING SYSTEMS IN THE NORTHERN AND CENTRAL GREAT PLAINS; A REVIEW OF THE LITERATURE. U.S. Dept. Agr., Agr. Res. Serv. Misc. Pub. 952, 64 pp. 1964.

The literature was reviewed to determine the value of legumes and grasses as soil-conserving and soil-improving crops in the northern and central Great Plains.

The following experimental data were summarized: (1) Comparison of crop yields in rotations with and without legumes and grasses; (2) comparison of legumes versus inorganic sources of nitrogen; (3) soil-moisture use by legumes and grasses; and (4) chemical and physical effects of legumes and grasses on soils.

Tables and charts.

ARS, USDA, Inform. Div., Room 645A, FCB, Hyattsville, Md., 20781

102. Adams, W. E., and Dawson, R. N. CROPPING SYSTEM STUDIES ON CECIL SOIL, WATKINSVILLE, GA., 1943-62. U.S. Dept. Agr., Agr. Res. Serv., 41-83 18 pp. 1964.

The principal row crops of the Southern Piedmont Plateau are corn and cotton. The greater part of the cultivated land has been seriously damaged by erosion. Thus, the most important and most difficult problems facing the farmers of the area are the conservation and improvement of their cropland. The use of cropping systems that will reduce water losses and at the same time improve the productivity of erosion-damaged soil is needed.

Erosion in the Southern Piedmont is due primarily to frequent, high-intensity thundershowers and the resulting runoff of rainfall from land in row crops. These storms occur primarily during the summer growing season and cause approximately 78 percent of the annual soil loss and 54 percent of the annual runoff.

Crops were grown in a series of cropping systems on three classes of Cecil soil to study the influence of the cropping system on crop yields, soil organic matter, and soil and water losses.

The authors concluded that: (1) Cecil soil, classes I and II land, produced good yields of corn and cotton when grown continuously when the crop was well fertilized and limed and the plant residues were returned to the soil; and (2) on steeply sloping soils, classes III and IV land, economic crop production was questionable unless perennial grasses or perennial legumes were included in the cropping system.

ARS, USDA, Inform. Div., Room 645A, FCB, Hyattsville, Md., 20781

103. Adams, W. E., Dawson, R. N., and Beaty, E. R. SOUTHERN PIEDMONT FIELD STATION EXAMINES CORN STOVER AND GRAIN PRODUCTION; AS RELATED TO CROPPING SEQUENCE, NITROGEN FERTILIZATION AND RESIDUE MANAGEMENT. Ga. Agr. Res. 5(4): 8-10. Spring 1964.

Various corn cropping systems, including winter cover crops and utilization of residues, on Cecil s1, Class IIe land at four nitrogen levels were studied for the 8 year period, 1955-62.

Returning corn stover did not increase either corn grain or stover production as compared to removing the stover. The organic carbon content of the soil was not influenced by stover removal. In general, there appeared to be no relationship between soil organic carbon and corn grain production.

Residual effects of 80 pounds of nitrogen per acre applied to the rye was equal to 40 pounds of nitrogen per acre applied directly to the corn. Rye increased the soil organic carbon but the increase in corn production was not sufficient to pay the cost of the rye seed and seeding, unless other uses were made of the rye, such as grazing. Maximum corn grain and stover production was generally obtained with 40 pounds of nitrogen per acre when corn was grown either with or without rye winter cover.

In continuous corn production, at the no-nitrogen level, vetch as a cover crop was superior to rye or no cover crop. There was no response to nitrogen in the corn-vetch cropping sequence.

Grain: stover ratios ranged from .61 to 1.18 pounds of grain per pound of stover. Grain production varied 350 percent over the 8 year period while stover production varied only 177 percent, due primarily to variations in rainfall.

Harvesting the corn stover more than doubled feed production per acre.

SWCRD, ARS, USDA, Watkinsville, Ga., 30677

104. Ramig, R. E., and Smika, D. E. FALLOW-WHEAT-SORGHUM: AN EXCELLENT ROTATION FOR DRYLAND IN CENTRAL NEBRASKA. Nebr. Agr. Expt. Sta. B. SB 483. 11 pp. 1964.

Three 3-year rotations (fallow-wheat-corn; fallow-wheat-sorghum; and fallow-wheat-wheat) with and without nitrogen on the crops were studied from 1953-62 at North Platte, Nebr., on Holdredge vfstl soil.

A 3-year rotation of fallow-wheat-sorghum using hybrid grain sorghum fertilized with nitrogen produced the highest gross income and provided for efficient use of water and nitrogen, downy brome grass control, and satisfactory wind erosion protection. This 3-year rotation fits well into present farm programs without loss of income in an area which was formerly cropped to fallow and winter wheat.

The application of 30 pounds of nitrogen per acre did not increase the yield of wheat after fallow in any of the 3-year rotations.

The application of 30 pounds of nitrogen per acre on wheat, corn, and sorghum after wheat significantly increased the yield of wheat 4 years out of 10 and the yields of corn and grain sorghum 6 years out of 10.

Nitrogen increased the crude protein content of all three grain crops.

Recovery of the nitrogen fertilizer by the grain in the wheat after fallow was 10 percent in the fallow-wheat-wheat rotation; 20 percent in the fallow-wheat-sorghum rotation; and 22 percent in the fallow-wheat-corn rotation. Recovery of the nitrogen fertilizer by the grain in the wheat, sorghum, and corn crops after wheat were respectively 17, 33, and 36 percent.

Corn and grain sorghum produced 2.18 and 3.49 bushels of grain per inch of water used when the crops were not fertilized. With the application of 30 pounds of nitrogen per acre, 2.89 bushels of corn and 4.91 bushels of grain sorghum were produced per inch of water used. The fertilized crops removed only 0.45 to 1.43 inches more water from the 10-foot soil profile than the nonfertilized crops.

SWCRD, ARS, USDA, Pendleton, Oreg., 97801

105. O'Keefe, R. B., Werner, H. O., Rhoades, H. F., and Chapman, H. W. TWENTY-THREE YEARS OF DRY-LAND CROP ROTATION EXPERIMENTS WITH POTATOES AND GRAIN CROPS IN NORTHWESTERN NEBRASKA. Nebr. Agr. Expt. Sta. Sta. B. 478, 43 pp. 1964.

Twenty-three years of data to determine the effects of length of rotation, summer fallow, cropping sequence, and weather factors on the production of the major dryland crops of the area—winter wheat, potatoes, barley, corn, and spring wheat were given. The author concluded that:

1. In contrast to the drought period of 1931-40, the period 1941-53 was characterized by lower temperatures, higher wind velocities, much higher precipitation, and reduced evaporation.
2. The effect of length of rotation on yields varied with crops. No statistical differences were found. However, with corn and potatoes, yields from 5-year rotations tended to be higher than those of 3-year rotations. Length of rotation other than continuous cropping had no effect on yields of small grain.
3. For the entire period, the mean yield of winter wheat was 27.3 bu./A. on fallow ground and 14.0 bu./A. in non-fallow rotations. The mean yield of potatoes produced on fallow ground was 120.4 bu./A., which was 21.3 to 48.3 bushels higher than on the non-fallow rotation.
4. Winter wheat and barley yields were higher when they were preceded by corn than when they were preceded by small grain. Barley yields were higher when the previous crop was potatoes than when it was corn, and the highest mean yield (36.0 bu.) was produced when 6 tons of manure per acre was applied to potato ground in the fall. In rotations which included 2 or 3 years of consecutive wheat crops, following barley, the yield of the second year crop was comparable to, or slightly better than, the first crop. Yields of corn following barley and wheat were comparable.
5. During the 1941-53 period, potato yields were lower after corn than after small grain, a reversal of the 1931-40 trend. Lowest yields were produced by the continuous potato plots.
6. The amount and distribution of yearly effective precipitation were by far the dominant factors affecting yields of the various crops throughout the 23 year period. Corn yields were determined by the amount and distribution of effective precipitation from June 1 to September 30 and were highest when the amount exceeded 6.31 inches. Barley and wheat yields were determined by the amount of well-distributed precipitation in the months of June and July. However, 2.5 inches of effective October 1 to May 31 precipitation was necessary to establish good stands of wheat, and June-July temperatures, wind movement, and evaporation were also limiting factors affecting yields. When soils were filled to their field-carrying capacity (7.5 inches) to a depth of 5 feet at planting time, good potato crops were produced, even when there was little effective seasonal rainfall. High potato yields were produced in seasons when effective preplanting precipitation of 5.75 inches or more was followed by more than 2.8 inches of effective summer rain.
7. Changes in nitrogen level of Rosebud soil in relation to cropping practice was determined over a 25 year period, 1930-55. The total amount of nitrogen lost (46 percent) was greater than in heavier silt loam and silty clay soils. Nitrogen losses increased as the percentage of row-cropping increased in rotations. The average loss of nitrogen from the 6 to 12 inch soil depth was 45 percent. In general, the loss from the 6 to 12 inch depth was greater than from the 0 to 6 inch depth and increased as the percentage of small grain crops in the rotation increased. Erosion and leaching apparently accounted for large losses of nitrogen from the 0 to 12 inch depth.

Tables and graphs.

U. Nebr. Col. Agr., Agr. Expt. Sta., Lincoln, Nebr.

106. Sims, J. L. GROWING ARABLE CROPS TO REDUCE AVAILABLE NITROGEN IN RESERVOIR SOILS. Ark. Farm Res. 8(3): 5. 1964.

A major problem associated with the production of rice on reservoir soils has been excessive vegetative growth and subsequent lodging of the crop. Large reductions in both yield and quality of grain often have been incurred when rice was grown on soils that had been inundated for the previous 2 or more years. Lodging is less likely to be a problem on reservoir soils of silt loam texture than on clay-textured reservoir soils.

Analyses of soil samples from reservoir and "old" rice field soils revealed that sufficient nitrogen accumulated during years of water submergence and/or fish production to be a major cause of lodging of a rice crop grown the following year. The feasibility of growing arable crops during the first year after water submergence to reduce the accumulated available nitrogen before a rice crop is grown the succeeding year was studied.

An experimental area was selected within a reservoir with clay soil which was known to have a high available nitrogen content. The reservoir had been used the previous 2 years for production of buffalo fish.

Analysis of a portion of a composite soil sample taken on March 3, 1961, showed a soil pH of 5.9, organic matter percentage of 2.8, and P_2O_5 , K, Ca, Mg, and Na contents of 95, 497, 3,442, 1,167, and 101 pounds per acre, respectively.

Average available nitrogen content of the soil under all three crops was reduced from 175 pounds per acre at seeding to approximately 40 pounds at harvest (Table 1). While using this amount of nitrogen, 38 bushels of soybeans, 2,780 pounds of grain sorghum, and 53 bushels of corn were produced. The comparatively low corn yield likely was due in part to the late seeding date.

Table 1. Average Available Soil N
Before and After Growing Arable
Crops on Reservoir Soil

Crop	N at seeding	N at harvest	N at seed- ing less N at harvest
Pounds per acre			
Soybeans	178	41	137
Grain sorghum	174	30	144
Corn	177	43	134

A relatively large amount of soil nitrogen was removed by the soybean crop although this crop is not generally considered to be a user of large amounts of soil or fertilizer nitrogen.

Approximately half of the ammonium N present at the March 3 sampling date had been oxidized to nitrate by soil microorganisms during the interval from March 3 to June 22 (Table 2). Further oxidation during the crop-growing season was indicated since nitrate N present at harvest was greater than ammonium N.

Nitrification of the ammonium to nitrate N prior to the growing of arable crops perhaps was of little consequence, as these crops were grown under dry land conditions. Had rice been seeded near June 22 and then flooded, the nitrate portion of the available soil nitrogen likely would have been lost to the rice crop through leaching or denitrification to gaseous N.

Table 2. Nitrogen Changes in
Reservoir Soil During Growth
of Arable Crops

Date (1961)	Nitrogen		
	Ammonium	Nitrate	Total
	Pounds per acre		
March 3 ¹	166	7	173
June 22 ²	86	90	176
Nov. 2 ³	8	30	38

¹Soil sampled 2 weeks after draining
reservoir.

²Seeding date of arable crops.

³Harvest date of arable crops.

Rice Branch Expt. Sta., Stuttgart, Ark.

Crop Residue Management

SEE 107, 108, 133.

Tillage

SEE ALSO 98, 194.

107. Moody, J. E., Moschler, W. W., Lillard, J. H., Shear, G. M., and Jones, J. N., Jr. REDUCED AND NO TILLAGE PRACTICES FOR GROWING CORN IN VIRGINIA. Va. Agr. Expt. Sta. B. 553, 12 pp. 1964.

Various tillage procedures under a range of soil and climatic conditions were studied in three physiographic regions of Virginia.

In all experiments, the tillage variables were in a randomized-block or split-plot design, and replicated four or more times. The author concluded that:

1. Wheel-tract planting produced corn yields comparable to those of conventional tillage in 18 experimental tests. The method was well adapted to coarser-textured soils where conditions favorable for uniform plowing and a well-shattered furrow slice existed. In the finer-textured soils of central and western Virginia, the practice worked well when the normal sod cover was properly inverted without excessive air pockets between furrows and the furrow slice was shattered sufficiently. On heavier soils, a suitable, correctly-adjusted plow and favorable soil moisture conditions was required; otherwise, stands and yields were depressed. Under proper planting conditions, compaction of the seed row by tractor wheels gave about the correct firmness, in most soils, for a desirable seedbed and optimum germination. Chemical weed control was an essential part of the procedure.
2. Strip-till planting gave results comparable to conventional tillage under a wide range of soil conditions, provided tillage was shallow and the seed row firmly compacted. It was well adapted to heavier-textured soils and sod crop conditions which make early plowing necessary. Chemical weed control was an essential part of the procedure.

3. In limited 2-year plot tests at Warsaw on Sassafras sl, lister-mulch planting of corn gave stands and yields comparable to those obtained with conventional tillage.
4. The no-tillage method has produced corn yields comparable to and sometimes exceeding those from conventional tillage. Tests were made under controlled plot conditions on three widely different soils, and with both killed grass-legume sod and killed small grain as mulches. Test results and experience indicate that the no-tillage method can be used successfully whenever existing vegetation can be killed and weeds controlled with herbicides; and where available planting equipment can reasonably meet sod planting requirements. Effective erosion control and effective water use, afforded by this method, provided excellent protection against both severe storms and droughts of short duration. Various kinds of crops were used as mulches, but the more dense grass and grass-legume mixtures provided the best moisture conservation.

Photographs.

Va. Agr. Expt. Sta., Va. Polytech, Inst., Blacksburg, Va.

108. Sanford, J. O., Bruce, R. R., Doty, C. W., Myhre, D. L., and Crockett, S. P.
TILLAGE PRACTICES FOR CORN. Miss. Agr. Expt. Sta. Inform. Sheet 855, 2 pp. 1964.

Four methods of seedbed preparation and post planting cultivation were evaluated on a Loring sil soil at the North Mississippi Branch Experiment Station in 1962-63. These methods were (1) Conventional planting; (2) wheeltrack planting; (3) lister planting; and (4) direct planting. Seeding emergence, corn grain yield, grass and weed control, and soil water content were measured. The following conclusions were made:

1. The lister planting and wheeltrack planting methods yielded about 30 percent more corn grain than either the conventional or direct planting method.
2. The lister planting, or mulch tillage, method significantly reduced the weed and grass problem. The wheeltrack planting method had significantly better grass and weed control than the conventional or direct planting method, but was slightly inferior to the lister planting method.
3. Seedling stand establishment was best for the wheeltrack and lister planting methods.
4. In general, the lister planting and wheeltrack methods were superior to the conventional and direct planting methods.

Table. Effects of tillage-planting methods on yield of corn.

Tillage-planting Method	1962	Yield of corn grain		Increase in yield over conventional
		1963	Average	
		bushels per acre		percent
Conventional	67a ¹	50a	58	-
Wheeltrack	76ab	73b	74	28
Lister	88b	69b	78	34
irect	66a	46a	56	-3

¹Any two means within a column followed by the same letter are not significantly different at the 5% probability level.

Miss. State U., Agr. Expt. Sta., State College, Miss.

109. Dasberg, S., and Amir, J. TILLAGE EXPERIMENTS WITH PEANUTS. Agron. J. 56(3): 259-261. 1964.

Peanuts were grown during 3 seasons on soil prepared to depths varying from 20 to 50 cm. The number and depth of inter-row cultivations were also varied.

Soil structure, as measured by penetrability and bulk density, was affected appreciably by the experimental treatments. The depth of soil preparation and of inter-row cultivation did not affect plant yields. The peanut yields decreased as the number of inter-row cultivations increased.

Natl. and U. Inst. Agr., Rehovot, Israel.

110. Steenberg, K., Njøs, A. VERTICAL DISTRIBUTION OF P32 LABELLED $\text{NH}_4\text{H}_2\text{PO}_4$ AFTER TILLAGE OPERATIONS WITH MOULDBOARD PLOUGH AND ROTARY CULTIVATOR. J. Agr. Engin. Res. 9(3): 241-244. 1964.

The turning effect of the moldboard plow and rotary cultivator was studied by means of a tracer technique using P32 labelled $\text{NH}_4\text{H}_2\text{PO}_4$. The rotary cultivator gave a considerably poorer turning effect than the plow.

Norges Landbrukshøgskole, Vollebakk, Norway.

111. Putnam, L. G., and Handford, R. H. POTENTIAL AND ACTUAL POPULATIONS OF GRASSHOPPER NYMPHS IN TILLED AND UNTILLED CEREAL GRAIN FIELDS. Canad. J. Plant Sci. 44(4): 365-375. 1964.

The within-season trends of grasshopper abundance in cultivated habitats were investigated during 7 years between 1943-60 in southwestern Saskatchewan and southern Alberta.

In untilled cereal grain fields, the numbers of grasshopper eggs declined by 0 to 67 percent from late fall to early spring. Tillage seldom affected this decrease substantially. Of the eggs surviving in the spring, 7 to 64 percent producing nymphs emerged. Tillage between egg-laying and emergence sometimes further reduced emergence. At the mid-point of nymphal development, when most eggs were hatched, nymphal mortality further reduced the population, from 2 to 20 percent of the eggs present earlier in the same spring. The most reliable effect of tillage as a control measure was the destruction of food plants, prior to grasshopper hatching, in the preparation of summer-fallow.

Of the surface-tilling implements, one-way disks were most effective, but implements preferred for preserving trash cover, such as blade and duck-foot cultivators, were also effective if used under conditions conducive to complete killing of food plants.

Res. Sta., Canada Dept. Agr., Saskatoon, Saskatchewan, Canada.

Fertility Requirements for Conservation Farming

SEE ALSO 27, 30, 32, 34, 36, 37, 38, 54, 56, 57, 58, 61, 70, 71, 73, 74, 75, 76, 80, 83, 84, 85, 86, 87, 90, 91, 103, 104, 151, 152, 201, 214, 249, 263, 264, 267.

112. Ibach, D. B., Adams, J. R., and Fox, I. E. COMMERCIAL FERTILIZER USED ON CROPS AND PASTURE IN THE UNITED STATES—1959 ESTIMATES. U.S. Dept. Agr., Econ. Res. Serv. Stat. B. 348, 201 pp. 1964.

Estimates of fertilizer use on individual crops in terms of principal plant nutrients for 1959 by States for the 50 States, for Puerto Rico, and for each of 99 agricultural subregions in the 48 contiguous States were given. Agricultural subregions reflect major differences in soils, in types of farming, and certain other economic criteria used in designating State economic areas in former census reports. Boundaries of subregions are not contiguous with State lines. Estimates were compiled by State parts of subregions, for each subregion as a whole, for each State and Puerto Rico, and for the United States and Puerto Rico combined.

For the purposes of this report, principal plant nutrients include nitrogen (N), available phosphoric oxide (P_2O_5), and potash (K_2O). Comparable data for both 1954 and 1959 were shown by agricultural subregions for corn, oats, wheat, cotton, tobacco, and hay and cropland pasture. Separate estimates confined to irrigated crops were included by States and subregions where the information was available.

Tables and maps.

MOS, USDA, Inform. Div., Washington, D.C., 20250

113. Long, O. H., Odom, J. A., and Safley, L. M. PHOSPHORUS AND POTASSIUM FERTILIZATION IN CROP ROTATIONS. Tenn. Agr. Expt. Sta. B. 376, 27 pp. 1964.

Yields of corn, wheat, and red clover in a 3-year rotation were summarized on three major soil series (Cumberland 1, Hartsells 1, and Dickson sil) at three locations in Tennessee (Knoxville, Crossville, and Springfield) for periods ranging from 10 to 13 years. The authors concluded that:

1. In the beginning three different sources of phosphorus—concentrated superphosphate (CSP), fused tricalcium phosphate (FTP), and rock phosphate (ROCK)—were compared, usually at two rates. Later, some phosphorus treatments were dropped, at which time the experiment was changed to a study of rates of phosphorus (CSP) and potassium. One ROCK treatment was continued throughout.
2. Significant yield responses to applied phosphorus were obtained with all three crops on all three soils. Assigning a value of 100 for the yields obtained with CSP, the average relative yield obtained with FTP on all crops at all locations was 95, while the relative yield obtained with ROCK at the higher rate was 76. ROCK was least satisfactory on wheat of the three crops studied.
3. In the rate studies of phosphorus and potassium, 40 pounds of P_2O_5 appeared to be ample for corn. Wheat continued to respond to phosphorus up to the last increment (80 pounds of P_2O_5 per acre), although the greatest response was to the first increment (40 pounds of P_2O_5).
4. Applications of potassium had little effect on yields on the Cumberland soil, but became of major importance on corn and red clover on a Dickson sil at Springfield. On this soil, corn and wheat responded to applications as high as 90 pounds of K_2O per acre.

5. Red clover was not fertilized directly. Difficulty was experienced in getting stands at Knoxville and Springfield.

Tables.

U. Tenn., Agr. Expt. Sta., Knoxville, Tenn.

114. Gasser, J. K. R. UREA AS A FERTILIZER. Soils and Fert. 27(3): 175-180. 1964.

The review of the literature on the use of urea as a fertilizer showed three main agronomic problems: (1) Presence of biuret as an impurity; (2) damage to germinating seed and young plants; and (3) loss of fertilizer nitrogen as ammonia from urea applied to the surface of soils. Biuret should be no problem as urea can be manufactured containing so little that the fertilizer is not toxic to plants. Damage to germinating seeds caused by ammonia may be lessened either by placing urea to the side of the seed and separated from it by soil, or by mixing urea with acid materials such as superphosphate.

Urea nitrate and urea phosphate may merit further consideration as fertilizers because both are well defined and easily made compounds, each containing anions to react with the ammonia formed on decomposition of urea. Urea nitrate contains 34 percent N, ammonium nitrate contains 33.5 percent N, and urea contains 45 percent N. Urea nitrate is only slightly water-soluble and under humid conditions may store and handle better than ammonium nitrate or urea. Urea phosphate has the same N:P ratio as diammonium phosphate, but slightly lower nutrient percentages.

Field experiments suggest that urea is as good as other N fertilizers for increasing yields of rice. For other crops, urea is a little inferior to ammonium nitrate and ammonium sulphate, and occasionally is markedly inferior because ammonia is lost from urea applied to the soil surface. Urea is useful as a foliar spray and may be used to apply additional nitrogen with routine insecticide, fungicide, and herbicide sprays. It is good for producing solutions of fertilizers.

Industrially, urea is synthesised from readily available materials, ammonia and carbon dioxide, and at present is sold on the international market more cheaply per unit of N than any other solid nitrogen fertilizer. Urea is also the most concentrated solid N fertilizer, so that distribution and spreading costs are lower than with other forms. These advantages are at present offset by the disadvantages of loss of ammonia from urea and damage to crops.

Bibliography.

No address given.

115. Morris, H. D. LIQUID AND SOLID FERTILIZERS FOR COASTAL BERMUDAGRASS. Ga. Agr. Res. 5(4): 16. Spring 1964.

In order to compare liquid and solid fertilizers, an experiment was initiated in April 1962 on Coastal Bermudagrass grown on Cecil sl at the University of Georgia Agronomy Farm near Athens. The eight fertilizer treatments utilized are given in the table. All treatments were replicated four times in a randomized complete block. Forage was harvested four times. The ovendry yields are also given in the table.

Table. Comparison of Liquid and Solid Fertilizers for Coastal Bermudagrass - Cecil Sandy Loam - Athens, Georgia 1962.

Treatment	Pounds per acre N-P ₂ O ₅ -K ₂ O	Forage yield per acre (oven-dry)				
		clipping				
		1	2	3	4	Total
1. Liquid 14-7-7	100-50-50	918	961	365	627	2871
2. Solid 16-8-8	100-50-50	703	1133	502	1156	3494
3. Liquid 14-7-7	200-100-100	1503	1462	646	1550	5161
4. Solid 16-8-8	200-100-100	1540	2214	960	2359	7073
5. Liquid N	200-100-100	2545	1913	905	1602	6965
Solid 0-12-12						
6. Liquid N	200-100-100	1527	1980	814	1704	6025
H ₃ PO ₄ + KCl						
7. Liquid N- + KCl	200-0-100	1275	1663	622	1525	5085
8. Liquid N-	200-100-100	1659	2086	898	2030	6673
H ₃ PO ₄ + KCl						

Notes: Treatments 1-4 applied 1/4 in April and 1/4 after each of first 3 clippings. KCl in Treatments 5-8 applied all in April. Superphosphate (20%) in Treatment 5 applied all in April. Liquid N (1/2 urea, 1/2 NH₄NO₃) in Treatments 5-8 applied in 4 equal applications. H₃PO₄ in Treatments 6 and 8 applied in 4 equal applications. Treatment 8 - Liquid N and H₃PO₄ mixed before applying.

The following conclusions were made:

1. Liquid fertilizers were inferior to solid fertilizers of comparable analysis for Coastal Bermudagrass production. The superiority of the solid fertilizers increased with rate of application.
2. Application of all phosphorus and potassium in solid form in April and of liquid nitrogen at each clipping was equal to applying complete fertilizer at each clipping.
3. Mixing urea and ammonium nitrate solution with liquid phosphoric acid immediately before applying gave significantly higher yields than applying nitrogen solution and then the phosphoric acid.

Col. Expt. Sta., U. Ga. Col. Agr., Athens, Ga.

116. Volk, G. M. SOLID NITROGEN VS. SOLUTIONS FOR TOPDRESSING PASTURES AND ROW CROPS. Fla. Res. Rpt. 9(1): 18-19. 1964.

Pelleted ammonium nitrate and solutions of ammonium nitrate or urea-ammonium nitrate were superior to pelleted urea for both pasture topdressing and row crop side-dressing. The solutions were equal to pelleted ammonium nitrate for side dressing on bare soil, but apparently were somewhat inferior to ammonium nitrate on the average for pasture fertilization. Close cutting or grazing immediately prior to fertilization might reduce this difference. Convenience of application of solutions could offset any lower response as compared to pelleted ammonium nitrate in situations where labor was at a premium.

U. Fla., Agr. Expt. Sta., Gainesville, Fla.

117. Thomas, J. R. INTERRELATIONSHIPS OF NITROGEN, PHOSPHORUS, AND SEASONAL PRECIPITATION IN THE PRODUCTION OF BROMEGRASS-CRESTED WHEATGRASS HAY. U.S. Dept. Agr., Agr. Res. Serv. Prod. Res. Rpt. 82, 27 pp. 1964.

The effects of nitrogen, phosphorus, and seasonal precipitation on the yield and forage composition of crested wheatgrass-bromegrass were evaluated.

Hay yields were significantly increased by nitrogen fertilizer. The highest rates of nitrogen gave the greatest residual response in the 4 years after application.

The effect of seasonal precipitation on hay production was affected by the fertility level. Significant grass response to phosphorus fertilizer was obtained with high seasonal precipitation and when the quantity of phosphorus applied exceeded the soil phosphorus absorption capacity.

Nitrogen content of the grass increased with the application of nitrogen fertilizer and diminished with increasing amounts of seasonal precipitation. The addition of phosphorus fertilizer increased the nitrogen percentage only in years of low rainfall.

Nitrogen carryover from the 160-pound applications significantly increased the grass nitrogen content for two cropping seasons.

Forage yields were significantly related to the percentage of nitrogen and phosphorus in the grass. In years of low rainfall, nitrogen was from 2.9 to 22.1 times more effective than phosphorus in determining yields. High hay yields were associated with grass having a high nitrogen content.

Recovery of the applied nitrogen fertilizer in the grass was affected by rate of application, seasonal precipitation, and adequacy of other nutrients. Maximum recovery of 63.4 percent was obtained with the 1953 application of 160 pounds of phosphorus.

High soil fertility favored a more rapid depletion of moisture from the surface 6 inches, but high fertility had no effect on moisture exhaustion from lower depths in the profile.

One inch of evapotranspiration produced 104 and 253 pounds of hay in 1956 on the 0- and 640-pound residual nitrogen treatments, respectively.

ARS, USDA, Inform. Div., Room 645A, FCB, Hyattsville, Md., 20781

118. Kresge, C. B. NITROGEN FERTILIZATION OF FORAGE MIXTURES CONTAINING DIFFERENTIAL LEGUME PERCENTAGES. Agron. J. 56(3): 325-328. 1964.

Red clover-orchardgrass and ladino clover-orchardgrass associations were established in which the percent legume was varied from 10 to 60 in 1961 and 5 to 65 in 1962. The percent legume as measured by the inclined point quadrant method represented the proportion of above ground live plant material occupied by the legume. Nitrogen was applied at rates of 0, 25, 50, and 100 lb./A. in split applications.

Red clover-orchardgrass in the first harvest year after establishment did not respond significantly to N application. In the second year, highest yields of red clover-orchardgrass were obtained with 100 pounds of N applied at legume percentages below 20. At most red clover percentages in 1962, there were significant yield increases from 25 to 50 pounds of N.

Ladino clover-orchardgrass responded to N fertilization in both years. The largest yield increase from 100 pounds of N occurred at legume percentages of 10, 15, and 20. Lesser increases were obtained at other rates and percentages. Nitrogen application of 100 pounds per acre reduced the 30 to 60 percent legume stands almost one-half.

Nitrogen content of the harvested forage was quite uniform for any one experiment. This uniformity reflected plant growth and legume changes during the season.

When the percent legume in a legume-grass mixture falls below 25 for ladino clover-orchardgrass or 20 for red clover-orchardgrass, the association should be fertilized as a pure orchardgrass stand.

Nitrogen application of legume-grass associations at legume percentages above 25 can result in increased yield, particularly during a dry summer. However, the economics of the operation and the danger of decreasing the legume stand should be carefully evaluated.

U. Md., Agr. Expt. Sta., College Park, Md.

119. Lynd, J. Q., Murphy, H. F. ALFALFA YIELD RESPONSE TO POTASSIUM, CALCIUM AND MAGNESIUM LEVELS WITH THREE SOIL TYPES. Okla. Agr. Expt. Sta. B. 622, 15 pp. 1964.

Soil characteristics and fertility levels are important factors that determine alfalfa yields and stand longevity. Field and greenhouse experiments were used to determine plant nutrient balance and needs of three soil types used for alfalfa production.

Results indicated need for evaluation of exchangeable potassium, calcium, and magnesium for determination of plant nutrient requirements of alfalfa.

Waynesboro 1 gave high yield response to fertilization with phosphorus, potassium, and boron. Yield depression after applications of magnesium was partially alleviated by phosphorus and potassium additions. Increased calcium application gave marked yield increases over the high magnesium treatments.

Moderate increases in hay yields were obtained on Port 1 with phosphorus and potassium additions, and slight increases resulted from boron application. High magnesium application decreased yields, but growth was increased with phosphorus, potassium, and calcium additions at the high magnesium rate.

Results with Norge 1 and Norge s1 soils indicated moderate-to-high yield response to phosphorus fertilization. The ratio or balance of potassium, calcium, and magnesium greatly influenced growth. Highly significant correlation was obtained on Norge s1 with yields increasing as the $\frac{K}{Ca + Mg}$ ratio increased as a function of potassium fertilization.

Dolomitic limestone (high Mg content) will supply both calcium and magnesium to soils and may require an adjustment in potassium application for a balance of these three important basic plant nutrients.

Okla. State U. Expt. Sta., Stillwater, Okla.

120. Englehorn, A. J., Pesek, J., and Shrader, W. D. ROLE OF NITROGEN, PHOSPHORUS AND POTASSIUM FERTILIZERS IN CONTINUOUS CORN CULTURE ON NICOLLET AND WEBSTER SOILS. Iowa Agr. Expt. Sta. Res. B. 522, 20 pp. 1964.

Corn yields taken on continuous corn and 3-year rotation blocks of a rotation experiment on the Iowa State University Agronomy Farm from 1915-53 show considerable variation in yield undoubtedly due to weather fluctuation. However, a downward trend in yields seemed to exist from 1915-36. The introduction of hybrid corn in 1937 increased corn yields. There was a further downward trend on the continuous corn block after 1938. In the 3-year rotation block, however, there was only a slight downward trend after 1938, followed by a slight rise through 1952.

Increased corn yields were obtained from manure and manure plus lime over no treatment, both with continuous corn and with corn in a 3-year rotation. Corn yields were considerably higher in the 3-year rotation as compared with continuous corn.

Original treatments on the two blocks were discontinued in 1952, and new treatments, including four levels of N with and without P and K fertilizer applied annually, were superimposed on subplots of the original plots. Effects of the former manure and lime treatments persisted, especially on the area without added N in the old continuous corn block.

The addition of N increased yields consistently and progressively through all levels of N on the old continuous corn plots.

The addition of phosphorus and potassium did not increase corn yields on the old continuous corn with N during the first years of the experiments, but did in later years.

Yields of corn obtained in the old continuous corn experiment were increased to high levels with large amounts of N and moderate levels of P and K.

Fertility treatments applied to the 3-year rotation block prior to 1953 seemed to have some influence on yields in subsequent years. Most persistent yield increases were from the earlier manure and rock phosphate treatments.

Corn yields were not increased from N during the first 5 years of continuous corn on the former 3-year rotation block, but were obtained after 1958.

Yield responses to P and K without N occurred only in the first years of the experiment while, with N, they were substantial and highly significant most years.

These data indicate that high corn yields on fertile soils can be maintained under continuous corn only when there is an adequate program of fertilizing with N, P, and K in balanced amounts.

Yield equations expressing the expected yield as a function of the fertilizer variables were given as a basis for recommendations for optimum fertilization of corn in these continuous corn experiments. Major treatment effects included were those of N, PK and $N \times PK$.

The addition of large amounts of ammonium nitrate for a period of 10 years did not significantly lower the pH value of the soil.

The amount of soluble soil P was increased significantly by the addition of phosphorus fertilizer. The amount of exchangeable K in the surface soil also was increased by the use of potassium fertilizer.

There were no apparent differences in organic matter resulting from the several fertilizer treatments.

Tables.

Agr. and Home Econ. Expt. Sta., Iowa State U. Sci. and Tech., Ames, Iowa.

121. Sherrell, C. G., Ketcheson, J. W., and Miller, M. H. THE EFFECT OF PLACEMENT OF BANDED FERTILIZER ON FERTILIZER PHOSPHORUS ABSORPTION AND YIELD OF OATS IN GREENHOUSE AND FIELD EXPERIMENTS. *Canad. J. Soil Sci.* 44(3): 329-336. 1964.

The effect of various placements of different rates of phosphorus fertilizer on fertilizer phosphorus absorption patterns and yield of oats in the field corresponded with those in the greenhouse. While fertilizer phosphorus absorption was greater from placements with the seed than from those to the side at all stages of growth, placements below the seed were superior to those with the seed in the early stages. At maturity, absorption from with-seed placement was greater than that from deeper placements.

Yield of oats was influenced by placement only on soil with a low phosphorus level. There was a significant interaction between distance and depth of placement and rate of phosphorus application in the greenhouse. Placement with the seed or 2 in. to the side and 2 in. below gave higher yields than any other placement at a high rate of application, and lower yields than any other placement at a low rate. A similar interaction was apparent in the field studies. This interaction could not be explained on the basis of fertilizer phosphorus content at any one growth stage.

It was concluded that the effect of placement of phosphorus fertilizer for oats depended on the rate of application and the level of soil phosphorus. Placements with or below the seed were found superior to placements beside the seed.

Dept. Soil Sci., Ontario Agr. Col., Guelph, Ontario, Canada.

122. Chiasson, T. C. EFFECT OF N, P, Ca, AND Mg TREATMENTS ON YIELD OF BARLEY VARIETIES GROWN ON ACID SOILS. Canadian J. Plant Sci. 44(6): 525-530. 1964.

Twelve barley varieties were grown on soils of pH 5.0 and 5.4. The varieties which performed best at the higher pH developed severe yellowing symptoms, had stunted growth, were late tillering, and produced very low yields when grown on the soil of lower pH.

Applications of 40 lb. of N and 44 lb. of P per acre in direct contact with the seed eliminated all symptoms and generally doubled yields on soils of pH 5.0.

Lime and (or) magnesium in direct contact with the seed had no influence on symptoms or yield.

Res. Station, Canada Dept. Agr., Fredericton, New Brunswick, Canada.

123. Timm, H., and Riekels, J. W. GROWTH, YIELD, AND COMPOSITION OF ONION, BARLEY, AND POTATO PLANTS AS AFFECTED BY PHOSPHORUS AND AMMONIACAL NITROGEN FERTILIZATION. Agron. J. 56(3): 335-340. 1964.

Under greenhouse conditions, onion, barley, and potato plants were grown in a highly organic mineral soil with an alkaline reaction (pH 8.2), high exchange capacity, and low available P. Three sources of ammoniacal nitrogen— $(\text{NH}_4)_2\text{SO}_4$, NH_4Cl , and NH_4NO_3 —were applied at the rate of 120 pounds of N per acre to 2 rates of P—52 and 105 pounds per acre—and to a control with no P. Fresh- and dry-weight yields of the plants were measured and the plant tissue analyzed for soluble $\text{PO}_4\text{-P}$, $\text{SO}_4\text{-S}$, $\text{NO}_3\text{-N}$, and Cl and total P and Mn content.

Growth of all plant species was increased significantly with P fertilization.

Growth of barley and transplanted onion plants was enhanced more by fertilization with NH_4Cl than was the growth of plants receiving $(\text{NH}_4)_2\text{SO}_4$ or NH_4NO_3 . This contrasted with the poor growth of direct-seeded onions and potatoes treated with NH_4Cl . Anion competition was demonstrated with a lower uptake of P, S, and N in the presence of Cl, which offered a partial explanation for the contradictory responses.

The presence of a minor element disorder was noted in the later stages of barley and potato plant growth, but the element or elements involved could not be specifically assessed.

U. Calif., Davis, Calif.

124. Ukkelberg, H. G., Harmon, S. A., Long, F. L. NITROGEN REQUIREMENTS OF SNAPBEANS IN THE LOWER COASTAL PLAIN OF GEORGIA. Ga. Agr. Expt. Sta. Mimeo. Ser. N.S. 196, 11 pp. 1964.

Ammonium nitrate and sodium nitrate were compared as sources of nitrogen for snapbeans in the spring and fall for 3 years on Eulonia vfst in Georgia. Two rates of nitrogen, 25 and 50 lb./A., were applied in the row before planting and five rates, 0, 25, 50, 100, and 150 lb./A., were used as a side dressing.

Ammonium nitrate and sodium nitrate produced approximately the same yield when 25 and 50 lb./A. was applied. Ammonium nitrate tended to produce higher yields than sodium nitrate when more than 50 lb./N/A. was used on both the spring and fall crops.

Snapbean yields were approximately the same when 50, 75, and 100 lb./A. of nitrogen, as ammonium nitrate, was applied to the spring crop, and were significantly higher than when only 25 lb./A. was used. Applying more than 100 lb./A. had a tendency to reduce yields. In the fall the trend was the same except that 25 lb./A. more was required to produce the highest yield.

When sodium nitrate was the source of nitrogen, the highest average yields were obtained from 50 lb./A. from both the spring and fall crops. More than 50 lb./A. did not increase yields and the general trend was a decrease with increased nitrogen rates.

Applying 50 pounds of nitrogen in two applications, 25 pounds before planting and 25 pounds as a side dressing, produced somewhat higher yields than when the 50 pounds of nitrogen was applied before planting. This was true in both the spring and fall and from both nitrogen sources. However, the differences obtained were not significant to the 5 percent level.

Col. Expt. Sta., U. Ga., Col Agr., Athens, Ga.

125. Mortensen, W. P., Baker, A. S., and Terman, G. L. SOURCE AND RATE OF APPLICATION OF PHOSPHORUS FERTILIZERS FOR VEGETABLES IN WESTERN WASHINGTON. Wash. Agr. Expt. Sta. B. 652, 32 pp. 1964.

Experiments comparing source and rates of application of phosphate fertilizers for vegetable crops were conducted from 1951-59 in western Washington.

Generally, the order of response to phosphate fertilization was cucumbers > pole beans > potatoes > sweet corn. Response to the water solubility of the P sources were in the same order except for potatoes and sweet corn. Potatoes required more P for maximum yields and generally produced larger relative responses than sweet corn. However, the latter generally responded more to increased water solubility of P sources.

Where other factors were not limiting or soil P levels were not high, all crops appeared to respond to water-soluble P. About one third of the available P should be in a water-soluble form for corn, potatoes, and beans, and one half or more for cucumbers.

Early-maturing, multiple-harvest crops require more of the applied P in a water-soluble form than later maturing crops because most of the response with the former occurs in the early harvests.

Sources, such as fused tricalcium phosphate, that contain no water-soluble P were generally inferior to the citrate-soluble materials containing water-soluble P, although some response was usually obtained even to these water-insoluble materials on the acid soils studied.

With a few exceptions, the proportion of water-soluble P in the fertilizer was positively related to the total P or P soluble in 2 percent acetic acid of recently matured leaf tissue sampled early in the growth cycle on all crops. The concentrations of P in early-sampled leaves of cucumbers and pole beans were well correlated with final yields.

Limiting yields were higher for cucumbers and possibly pole beans and sweet corn with materials high in water-soluble P than with dicalcium phosphate.

There was some indication that band-applied, slightly-soluble P sources were more efficient suppliers of P when finely ground. Efficiency, for the most part, appeared to be independent of particle size when highly water-soluble P sources were applied in bands.

Banded solutions of P materials appeared to offer no advantage over dry materials. Phosphoric acid was inferior to other water-soluble sources for cucumber and pole beans.

Tables.

Wash. Agr. Expt. Sta., Inst. Agr. Sci. Wash. State U., Pullman, Wash.

126. Jordan, H. V. SULFUR AS A PLANT NUTRIENT IN THE SOUTHERN UNITED STATES. U.S. Dept. Agr., Agr. Res. Serv. Tech. B. 1297, 45 pp. 1964.

Sulfur supplies and requirements for crops in the southern United States were studied.

Profile samples of representative soils were analyzed for sulfate sulfur by two methods. The samples were also analyzed for "available" sulfur and "reserve" sulfur. Sulfate sulfur and available sulfur were relatively low in surface soils but there were accumulations in deeper horizons. Reserve sulfur, (largely organic) was more plentiful in the surface than in deeper horizons.

Sulfur in rainfall and the atmosphere and that supplied by insecticides make only a minor contribution to crop needs in most areas in the southern tier of States. Availability of sulfate concentrated at different depths in the soil profile varied as a source of sulfur to crops.

Sulfur as an incidental component of many fertilizer materials has been the principal source of this nutrient for crops. However, new fertilizers that are low in sulfur, or even sulfur-free, are coming into use. In field experiments, sulfur-free fertilizers applied alone and with supplements of sulfur as gypsum were compared. Supplementary sulfur increased yields in 15 of 22 experiments with cotton, forage, and tobacco. Four or eight pounds of sulfur, band-placed with the fertilizer, was usually adequate for maximum yields.

Broadcast applications of gypsum were less effective than band applications. A single broadcast application at a reasonable rate did not prove completely satisfactory as a source of sulfur for crops beyond the first year after application.

Chemical testing methods were satisfactory only for identifying soils that were either well supplied or seriously deficient in sulfur for crop needs.

Cotton, clovers, and tobacco absorbed sulfur readily as increasing amounts were applied with fertilizer. Deficiency levels of plant sulfur were defined for some crops.

Interactions of nitrogen $\times$ sulfur and phosphorus $\times$ sulfur demonstrated the interdependence of sulfur nutrition and the general fertility level.

Farm operators in much of the South can no longer rely on incidental additions of sulfur from rainwater, atmosphere, insecticides, and fertilizers if crop production is to be maintained or increased.

Tables, graphs, and photographs.

ARS, USDA, Inform. Div., Room 645A, FCB, Hyattsville, Md., 20781

127. Fox, R. L., Flowerday, A. D., Hosterman, F. W., Rhoades, H. F., and Olson, R. A. SULFUR FERTILIZERS FOR ALFALFA PRODUCTION IN NEBRASKA. Nebr. Agr. Expt. Sta. R.B. 214, 36 pp. 1964.

The extent of sulfur deficiencies in some of the low organic matter soils of Nebraska was determined. Field, greenhouse, and laboratory experiments were conducted with alfalfa grown on soils from widely separated locations north of the Platte River.

Conditions ranged from severe sulfur deficiencies to no evidence of deficiency. Severe deficiencies of field locations were usually found on highly leached, sandy soils low in organic matter. A sandy soil, relatively high in organic matter and underlain by silt loam loessial material, developed a moderate sulfur deficiency during 6 years of continuous alfalfa production. This suggests the probability of widespread deficiencies developing where high crop yields make heavy demands upon the sulfur supplying power of the soil.

On sandy subsoils which have been undercovered by wind erosion, greenhouse tests and field observations indicate that sulfur nutrition of alfalfa is a major problem.

Gypsum and elemental sulfur as fertilizers for alfalfa differed only slightly in effectiveness when particle size and placement were optimum for both. Elemental sulfur must be very finely divided, e.g., particles less than 0.1 mm. diameter, for best results.

The carotene content of alfalfa deficient in sulfur and phosphorus was increased by sulfur fertilization and particularly by fertilization with sulfur plus phosphorus. Phosphorus alone had no effect.

The protein content of alfalfa grown on sulfur-deficient soils was increased by sulfur fertilizer. Where deficiencies were minor or did not exist, a decrease in protein percentage was sometimes noted.

Sulfur fertilizers increased the sulfur content of alfalfa grown in the greenhouse and the field. Data suggested that a sulfur concentration in the range of 0.22-0.25 percent at the tenth bloom stage is essential for optimum growth and yield.

Sulfur-yield values for three to four cuttings of alfalfa in the field ranged from 5.6 to 30.5 pounds of sulfur per acre.

The residual effect of a 50-pound application of sulfur was evident in alfalfa yields after 2 years.

The sulfur content of precipitation was measured for 2 years at seven locations in Nebraska. Sulfur in precipitation was related to population density and industrial activity. South of Omaha the sulfur in precipitation averaged 11.7 pounds per acre per year. In Pierce and Cherry Counties, precipitation added only 4.1 pounds of sulfur per acre per year. These amounts of sulfur are not sufficient to maintain a high level of production of such crops as alfalfa.

The effectiveness of a soil test involving phosphate extraction for indicating need for supplemental sulfur was established. Calibration of this test suggested assured response below 6 p.p.m. sulfur, possible response in the range of 6-10 p.p.m., and unlikely response above 10 p.p.m.

U. Nebr. Col. Agr., Agr. Expt. Sta., Lincoln, Nebr.

128. Younts, S. E. RESPONSE OF WHEAT TO RATES, DATES OF APPLICATION, AND SOURCES OF COPPER AND TO OTHER MICRONUTRIENTS. *Agron. J.* 56(3): 266-269. 1964.

Several rates of copper as copper sulfate were applied at different dates to winter wheat growing on high organic matter soils (Hyde sil) and low organic soils (Lynchburg 1) during 2 growing seasons, 1960-61 and 1961-62. In the 1961-62 season, a tribasic copper sulfate treatment and copper chelate treatments were also included. The copper chelate was applied both in the solid and spray forms while the two sulfate sources were always broadcast in the solid form. Manganese, zinc, and iron were included during the first season and manganese and zinc the second season.

For both the high organic matter and low organic matter soils, 2.5 lb./A. of copper resulted in either maximum or near maximum yields. Where the soil was not extremely deficient in copper, applications at planting on February 15 and March 15 were equally effective. Where the soil was acutely deficient, applications at planting and on February 15 were superior to those on March 15. Applications made as late as April 15 were of little or no benefit to the existing crop except where the soil was not extremely copper deficient.

The three sources of copper—copper sulfate, tribasic copper sulfate and copper chelate—gave comparable results. The chelate applied as a foliar spray was also effective in correcting deficiencies.

No yield response was obtained from the application of manganese, zinc, and iron.

The copper content of wheat plants sampled on April 26 tended to increase as the rate of copper applied was increased. Plants that were treated at planting had lower copper concentrations than plants treated in February and March. The application of manganese tended to increase the copper content while zinc tended to decrease the level of copper in the plant.

N.C. Agr. Expt. Sta., N.C. State Col., U. N.C., Raleigh, N.C.

129. Keogh, J. L., Mapes, R., and Hardy, G. W. METHODS OF APPLYING BORON FOR COTTON. Ark. Farm Res. 8(2): 13. 1964.

Three experiments were established in 1962 to evaluate methods of application of boron to cotton in Arkansas. The results are given in the tables.

Table 1. Effects of various Methods of Boron Application on Seedcotton
Yields at Three Locations in Lee County in 1962

Treatment and lb. boron per acre	Benson Farm, Loring silt loam		Thomas Farm, Loring s. loam		Smith Farm, Calloway s. loam	
	Treated	Check	Treated	Check	Treated	Check
Pounds seedcotton per acre						
1 lb. broadcast on bed before planting prep.	1,740	1,600	2,196	1,819	2,209	1,747
1 lb. broadcast after planting	1,742	1,710	2,070	1,839	2,013	1,792
.5 lb. pre-emergence or side- dress in 12-inch band	1,720	1,595	2,057	2,060	1,975	1,848
.1 lb. foliar, 8 times	1,698	1,585	1,943	1,734	2,204	1,714
Average	1,725	1,624	2,062	1,854	2,100	1,775

Table 2. Effects of Various Methods of Boron Application on Seedcotton
Yields at Two Locations in 1963

Treatment and lb. boron per acre	Dennis Farm St. Francis Co. Grenada sil loam		Garrett Farm Jefferson Co. Soil unclass.
	Pounds per acre ¹		
None	908 f		2,322 c
1 lb. broadcast pre-emerge	1,417 cd		—
.5 lb. pre-emerge, 12-inch band	1,492 b		2,455 ab
.3 lb. in fertilizer	1,398 de		—
.1 lb. foliar, weekly beginning June 28, 8 times	1,560 a		2,337 bc
.2 lb. foliar, 4 times, July 3, 18; Aug. 5, 12	1,430 bcd		2,459 ab
.4 lb. foliar, twice, July 10 & 26	1,383 de		2,478 a
.8 lb. foliar, once, July 18	1,494 b		2,450 ab

¹In each column, yields followed by the same letter do not differ significantly at the 5 percent point, by Duncan's Multiple Range test; yields not followed by the same letter do differ.

No method of application was consistently superior.

If boron deficiency symptoms do develop, either with or without soil application of boron, foliar application may give a yield response.

Eastern Ark. Soil Testing and Res. Lab., Marianna, Ark.

130. Moore, B. W., Patrick, H., Johnson, J. R., and Hyre, H. M. COMPOSITION AND PRODUCTION OF POULTRY MANURE. W. Va. Agr. Expt. Sta. B. 496T, 7 pp. 1964.

Poultry manure is a valuable fertilizer. Cage hens produce approximately 1.04 pounds of wet manure (25.65 percent dry matter) per pound of feed consumed. The floor managed hens cast manure containing about 4 percent less moisture than cage hens. Also, floor (loose) managed hens cast about 75 percent of their manure into the pits (feeders and waterers were placed above the pits). Fresh laying hen manure on a dry matter basis contained approximately 3.7 percent of N, 3.8 percent of P_2O_5 , and 2 percent K_2O .

Broiler litter after one brood of broilers contained about 3.3 percent N, 3.37 percent P_2O_5 and 1.7 percent K_2O when dry.

W. Va. U., Agr. Expt. Sta., Morgantown, W. Va.

131. Corder, G. D., and Miller, H. F. FARM MANURES—PRODUCTION—VALUE—USE. Ky. Coop. Ext. Serv. C 593, 10 pp. 1964.

More than 16 million tons of manures are produced annually by livestock and poultry in Kentucky. The estimated value of these manures based on their nitrogen, phosphorus, and potassium content alone is more than \$47 million.

Methods of preserving, storing, and handling of animal manures were given. The following tables were given.

Table 1. Approximate Annual Manure Production by Animals and Groups of Birds¹

Kinds of Animals	Approximate Annual Manure Production Excluding Bedding, Tons
Horses and mules	11.0 per 1,200-lb animal
Dairy cows and heifers.....	13.0 per 1,000-lb animal
Beef cows and heifers.....	8.5 " " " "
Steers.....	7.0 " " " "
Bulls.....	8.5 " " " "
Hogs.....	2.0 per 200-lb animal
Sheep.....	1.2 " " " "
Hens over 4 months.....	18.0 per 1,000 birds
Broilers up to 10 weeks.....	2.25 " " "
Turkey up to 26 weeks.....	22.0 " " "

¹Information taken from Ky. Coop. Ext. Circ. 468, "Productive Soil" (now out of print), and Feeds and Feeding, 22nd edition, Frank B. Morrison, Chap. XXIV.

Table 2. Average Amounts and Combined Value of N, P, and K in Fresh Manures From Different Farm Animals¹

	Percent Water	Pounds Per Ton			Value Per Ton ³
		N	P ²	K ²	
Dairy cattle.....	79	11.2	2.0	10.0	\$2.32
Fattening cattle.....	80	14.0	4.0	9.0	2.98
Hogs.....	75	10.0	2.8	7.6	2.19
Horses and mules.....	60	13.8	2.0	12.0	2.76
Sheep.....	65	28.0	4.2	20.0	5.36
Chickens.....	54	31.2	8.0	7.0	5.68

¹See Table 1, footnote 1.

²Phosphorus (P) can be converted to P₂O₅ by multiplying the figures given above by 2.29, and potassium (K) can be converted to K₂O by multiplying by 1.2.

³Calculated on the assumption that nitrogen (N) retails at 12¢, phosphorus (P) at 19¢, and potassium (K) at 6¢ per pound in commercial fertilizers.

Table 3. Secondary and Micronutrients in Fresh Manures from Different Kinds of Animals¹

Kind of Animal	Pounds of Nutrients per Ton							
	Secondary			Micronutrients				
	Cal-cium	Mag-nesium	Sul-fur	Boron	Copper	Iron	Manga-nese	Molyb-denum Zinc
Dairy cattle...	5.6	2.2	1.0	0.03	0.01	0.08	0.02	0.002 0.03
Fattening cattle.....	2.4	2.0	1.7	0.04	0.01	0.08	0.01	0.001 0.03
Hogs.....	11.4	1.6	2.7	0.08	0.01	0.56	0.04	0.002 0.12
Horses and mules.....	15.7	2.8	1.4	0.03	0.01	0.27	0.02	0.002 0.03
Sheep.....	11.7	3.7	1.8	0.02	0.01	0.32	0.02	0.002 0.05
Chickens.....	74.0	5.8	6.2	0.12	0.03	0.93	0.18	0.011 0.18

¹See Table 1, footnote 1.

132. Roehrkas, G. P. ECONOMICS OF FERTILIZER USE AND ANALYSIS OF NITROGEN USE ON BARLEY. Wyo. Agr. Expt. Sta. B. 411, 35 pp. 1964.

The basic agronomic and economic relationships and principles of fertilizer use were given along with an economic analysis of nitrogen use on irrigated barley. Experiments were conducted in the Big Horn Basin near Powell, Wyo., for a 3-year period, 1959-61. The experimental design was a randomized complete block with four replications.

Data from the nitrogen fertilizer experiments were used to estimate nitrogen barley response functions for each of the 3 years and an average function for all 3 years.

Under average price conditions, with barley worth \$.90 per bushel and nitrogen cost \$.13 per pound for actual nitrogen, the "optimum" level of nitrogen fertilization was 108 lb./A. However, the optimum level of fertilization generally changed under different nitrogen barley price ratios. A graph was prepared which provides a simple and convenient method of determining the "optimum" level of nitrogen fertilization under different nitrogen barley price conditions.

Since fertilizer use is only one of many practices and investment opportunities that are available to the farmer, the farmer should consider fertilizer use as an integrated part of his entire farming operations. Thus, to maximize returns to the farm the marginal productivity of capital should be equal in all available investment opportunities. A graph was prepared to facilitate the estimate of the level of nitrogen fertilization that will return a specified rate of return to capital invested in nitrogen fertilizer.

U. Wyo., Agr. Expt. Sta., Laramie, Wyo.

Salinity and Alkali Problems

SEE ALSO 20, 24, 25, 27, 59, 62.

133. Carter, D. L., and Fanning, C. D. COMBINING SURFACE MULCHES AND PERIODIC WATER APPLICATIONS FOR RECLAIMING SALINE SOILS. Soil Sci. Soc. Amer. Proc. 28(4): 564-567. 1964.

Water applied by periodic sprinkling of surface mulched soil resulted in greater salt and higher leaching efficiency than did either flooding or periodic sprinkling of bare soil. Cotton (*Gossypium hirsutum*) bur and chopped shrubby mulches were about equally effective. Flooding and sprinkling bare soil decreased salt concentration in the surface 2 feet of the soil profile, but salt accumulated below a depth of 3 feet when compared with check soil that received only rainfall. Similarly, salts were removed from all depths to 5 feet where surface mulches were present. The salt leaching efficiency decreased from about 90 percent in the surface foot to approximately 33 percent in the fifth foot of surface-mulched soil. The higher leaching efficiency for mulched soil was attributed to reduced evaporation under mulches that lessened upward movement of water.

SWCRD, ARS, USDA, Twin Falls, Idaho, 88301

134. Carter, D. L., and Myers, V. I. SOIL CHEMICAL AND PHYSICAL PROPERTIES ASSOCIATED WITH DEPRESSIONAL SALINE AND ADJACENT AREAS IN TWO GRAPEFRUIT GROVES. Rio Grande Valley Hort. Soc. 18: 51-60. 1964.

Some chemical and physical properties of saline, transitional, and unaffected soils in two grapefruit groves were studied in relation to tree growth, surface elevation, and depth to the water table. Saline areas where trees had died, transitional

areas where tree growth was stunted and salt toxicity symptoms were exhibited, and unaffected areas where trees appeared healthy and productive were sampled.

The saline soils contained extremely high salt concentrations in the surface few inches but salt concentration decreased sharply with depth. Transitional soils contained salt concentrations near the critical level for grapefruit trees. Unaffected soils were low in salt.

The saline soils contained mostly calcium, magnesium, and sodium chlorides. About two-thirds of the cations were $\text{Ca}^{++} + \text{Mg}^{++}$, and the other one-third, $\text{Na}^+.\text{Cl}^-$ composed over 90 percent of the soluble anions in saline soils, whereas only very small quantities of Cl^- were found in transitional and unaffected soils. HCO_3^- was the predominant anion in unaffected soils where total salt concentration was low.

Unaffected soils were higher in surface elevation than saline soils. Transitional soils were a little higher than saline soils. The water table was always nearer the surface of saline, depressional locations than at the other locations sampled. Irrigation and heavy rainfall cause high water table periods, more salt accumulates in the low saline areas because of more evaporation.

Soluble salts accumulate in the surface few inches of soil where the water table is near enough to the soil surface to allow continuous upward water movement and evaporation. Such soils will not produce citrus without intensive management practices. Only soils with adequate drainage should be planted to citrus. It is important to study the water table conditions of any area, particularly low areas, where citrus planting is anticipated. A high water table encompassing the root zone for a few weeks may retard or kill citrus trees. Because of the proximity to the water table, fluctuations that have little or no effect on unaffected soils with deep water tables may have severe adverse effects in depressional areas.

SWCRD, ARS, USDA, Twin Falls, Idaho, 88301

135. Abel, G. H., and MacKenzie, A. J. SALT TOLERANCE OF SOYBEAN VARIETIES (GLYCINE MAX L. MERRILL) DURING GERMINATION AND LATER GROWTH. Crop Sci. 4(2): 157-161. 1964.

Six soybean varieties were evaluated for their reactions to salinized soil during germination and later growth.

Seed germination studies at $28^\circ \text{C} \pm 1^\circ$ with soil salinities ranging from 3.1 to 13.7 millimhos/cm. showed that salinity decreased percent and rate of emergence. The decreases in rate of emergence of some varieties were greater than those of others. The varietal differences in emergence rate at the lower salinities were not related to the differences in emergence rate at the higher.

Growth was evaluated in the field in soil differing in salinity from 5.0 to 10.2 millimhos/cm. Salinity modified a number of the growth characters of 4 varieties much more than those of 2 varieties considered salt tolerant. The changes caused by increased salinity were: (1) Increased plant mortality; (2) increased leaf necrosis; (3) reduced green leaf color; (4) decreased dry stem production; (5) decreased seed yield; (6) decreased seed quality; and (7) increased accumulation of chloride in stems and leaves. Salt decreased plant height and leaflet size of all varieties essentially the same amount.

Uptake of chloride in stems and leaves of salt tolerant varieties was controlled to an exceedingly low level. The more salt sensitive varieties accumulated large amounts of chloride and plant mortality occurred when chloride contents of stems and leaves exceeded 15,000 p.p.m. and 30,000 p.p.m., respectively.

There was no apparent relation between the salt tolerances of a variety during germination and during later growth phases.

Southwestern Field Sta., CRD, ARS, USDA, Brawley, Calif.

136. Jacobs, H. S., Dixon, R. M., Lynn, W. C., and Naddih, B. I. IRRIGATION EFFECTS ON KANSAS SOILS. Kans. Agr. Expt. Sta. Tech. B. 134, 94 pp. 1964.

A wide range of soil and water properties was encountered in the 36 soils and waters studied. Soil texture ranged from loamy sand to silty clay loam. Mean soil saturation percentage varied from 25.7 to 54.9. Mean exchangeable sodium percentage and electrical conductivity of the saturation extract ranged from 0.14 to 12.91 and from 0.42 to 5.63 mmhos. per cm. at 25° C., respectively. Electrical conductivity of the irrigation waters varied from 0.38 to 4.82 mmhos. per cm. at 25° C.

Gapon's proportionality factor was significantly related to mean soil saturation percentage and to mean surface area. Soil saturation percentage was used to predict the proportionality factor for use in Gapon's equation for individual soils. Resulting exchangeable sodium percentage predictions were about 30 percent more efficient than predictions based on soluble sodium percentage or the sodium adsorption ratio.

Soil saturation percentage was significantly related to the change in concentration taking place as irrigation water changes to soil solution. Saturation percentage was used to predict the concentration change for individual soils. Resulting predictions of soil saturation extract electrical conductivity were 11 percent more efficient than predictions based on electrical conductivity of the water alone.

Some soils had been irrigated for only short periods of time so further changes in their properties may occur. The Las, Las Animas, and Sears imperfectly drained soils accumulated salt and sodium similarly to the well drained soils.

Tables and charts.

Agr. Expt. Sta., Kans. State U., Manhattan, Kans.

Cover Crops and Green Manure Crops

SEE ALSO 103.

137. Sawada, Y., Nitta, K., and Igarashi, T. INJURY OF YOUNG PLANTS CAUSED BY THE DECOMPOSITION OF GREEN MANURE [MANURE]. Soil Sci. Plant Nutr. 10(4): 163-169. 1964.

The period covering the first flush of decomposition of green manure is very unfavorable for the germination and the growth of young plants. In general, the external symptoms are yellowing and stunting of the shoots and noticeable necrosis of the root-tips or shoots. Although only slightly affected, the growth of young plants seems to be more or less retarded. The symptoms are almost the same in various crops such as oats, beans, corn, potato, and so on.

In field and laboratory experiments, the injury of oats seedlings were observed in an early stage of the decomposition of the green manure (red clover). From the CO₂ aeration experiment and the experiment in which the green manure was applied to the soil surface, it was found that the injury caused by green manuring was unlikely to be due to the composition of the soil air.

Partial sterilization of soil by heat after incorporation of the green manure, and with formalin before incorporation, was evidently effective in preventing injury to the seedlings. It was concluded, therefore, that a certain soil fungus associated with the decomposition of the green manure might be a factor most concerned.

A fungus belonging to Pythium was isolated as a casual fungus from the injured tissues.

Hokkaido Natl. Agr. Expt. Sta., Hokkaido, Japan.

Climatic Influences

SEE ALSO 2, 4, 5, 21, 46, 49, 52, 57, 97, 102, 105, 107, 126, 127, 187, 189, 204, 216.

138. Hershfield, D. M. THE FREQUENCY OF SMALL DAILY RAINFALL AMOUNTS IN EASTERN UNITED STATES. Internat'l. Assoc. Sci. Hydraul. 9(1): 5-11. 1964.

A simple procedure was presented for estimating the frequency of daily rainfall totals up to 1-inch in magnitude for the United States east of 100° W. Realistic results can be obtained from three relationships presented in the form of diagrams and the two generally available statistics: mean annual precipitation and mean annual number of days of precipitation greater than or equal to .01 inch.

The procedure gives reasonably accurate results, particularly for the rainfalls which occur frequently. This procedure can probably be extended to other regions by using thresholds other than the .01 and the 1 inch considered here.

SWCRD, ARS, USDA, Beltsville, Md., 20705

139. Huff, F. A., and Changnon, S. A., Jr. DROUGHT CLIMATOLOGY OF ILLINOIS. Ill. Dept. Registration and Ed. B. 50, 68 pp. 1963.

Analyses of the frequency distribution of droughts for periods of 3 to 60 months indicate that the relative severity of droughts, in general, is greatest in the south-eastern, extreme southern, and southwestern regions of the State.

The relative severity of droughts decreases with increasing length of dry period, and extensive, severe droughts of more than 24 months are infrequent in Illinois.

The climatological investigation of droughts in the 1906-1955 period revealed that the severest droughts of long duration were associated with the occurrence of severe short-duration droughts. Therefore, knowledge of severe 3-, 6-, and 12-month droughts is important to the understanding of all precipitation droughts in Illinois.

Many of the basic characteristics of short-duration droughts were common to droughts of all durations. In general, the regions of greatest drought severity were elongated, and the orientation of this major axis varied from SW-NE in the shorter droughts to the NW-SE and N-S in droughts of 36 months and longer. In most droughts, these regions of maximum severity were portions of droughts occurring in nearby states. Frequently two distinct areas of severity occurred in Illinois during a particular drought period.

Inspection of the time distribution of droughts of each duration did not produce evidence of drought cycles. For all durations, the worst drought in the 1906-1955 period with respect to severity and areal extent occurred in the 1930's. A major drought-free period extended from 1943 through 1951. For droughts of 3, 6, 12, and 24 months, analyses indicated a 50 percent probability that another drought of the same duration would occur somewhere in Illinois within approximately 30 months after a similar drought had terminated.

Ill. State Water Survey, Urbana, Ill.

140. Pelton, W. L. EVAPORATION FROM ATMOMETERS AND PANS. Canad. J. Plant Sci. 44(5): 397-404. 1964.

Daily measurements of evaporation from the porous disk and Bellani plate atmometers, the Class A evaporation pan, and the Experimental Farms buried tank were compared and related to daily measurements of temperature, radiation, wind, and vapor pressure. Simple correlation coefficients indicated highly significant relationships among evaporation measurements (dependent variables) and the meteorological factors (independent variables) with the exception of wind.

Multiple regression analyses showed highly significant correlations between each of the evaporimeters and the four meteorological variables studied. A linear combination of the four independent variables accounted for 70 to 86 percent of the variation in evaporation from the four evaporimeters, but the standard errors of estimate were also large. These four meteorological variables were of about equal importance in their influence on evaporation on the Canadian Prairies. Advected energy played a more important role than it has in more humid climates.

Expt. Farm, Canada Dept. Agr., Swift Current, Saskatchewan, Canada.

141. Pickett, B. S., and Bailey, M. H. FREEZE PROBABILITIES IN TENNESSEE. Tenn. Agr. Expt. Sta. B. 374, 27 pp. 1964.

Risk of severe crop damage from unseasonal freezing temperatures is great enough in Tennessee to make consideration of this problem important to most phases of the state's agriculture. Other phases of the economy, such as recreation, commerce, and industry, also are influenced by freezing and sub-freezing temperatures.

Probabilities of spring and fall freezing temperatures was presented. Ways this information can be used in planning farm operations were given.

U. Tenn., Agr. Expt. Sta., Knoxville, Tenn.

MULCHING

SEE ALSO 133, 143.

142. Cochran, B. J., Wilkes, L. H., Niles, G. A., Dudley, D. I., and Thaxton, E. L. THE EFFECTS OF A PETROLEUM MULCH ON THE GROWTH AND DEVELOPMENT OF COTTON. Tex. Agr. Expt. Sta. Prog. Rpt. 2312, 12 pp. 1964.

Planting studies were conducted at College Station, Denton, and Pecos, Tex., to determine the effects of a petroleum mulch on soil temperature, soil moisture, seedling emergence, maturity rate, and cotton yield. Petroleum mulch provided a daily average increase of 3° to 6° F. in soil temperature at a 2-inch depth under a petroleum mulch film.

There was no difference in soil temperatures at 2-inch depth among rates of mulch from 25 to 400 gallons per acre.

Soil moisture in the seed placement zone at 2 inches during the emergence period was only slightly affected by the mulch. However, there was more total moisture in the covering soil above the seed.

The rate and total number of seedlings to emerge was higher in the mulch plots planted early in the season. There was a decrease in seedling emergence under the mulch for late planted-cotton. Petroleum mulch showed no effect on the rate of maturity or an economical yield increase when used with conventional planting practices.

Tex. A&M U., Tex. Agr. Expt. Sta., College Station, Tex.

143. Donoho, C. W., Jr., Howlett, F. S., and Curry, R. B. APPLE IRRIGATION AND MULCH. Ohio Farm and Home Res. 49(3): 40-41, 43. 1964.

Mulch and irrigation treatments listed in Table 1 were begun in 1962 on a Franklin and Richared orchard planted at Wooster, Ohio in 1955. This orchard is planted on a Wooster sil soil which has a very high available water content.

Measurements were made to determine the influence of irrigation and mulch treatments on yield, size, color, firmness, soluble solids, acid content of the fruit, and nutrition of the trees.

TABLE 1. Influence of Irrigation and Mulch on the Average Yield (lbs/Tree) of Richared and Franklin Apple Trees. Wooster, Ohio.

Treatments	Pounds of Fruit Per Tree			
	Richared		Franklin	
	1962	1963	1962	1963
1. Sod	92	183	84	65
2. Sod + Moderate Irrigation	113	227	88	91
3. Sod + High Irrigation	87	187	61	63
4. Mulch	81	173	107	150
5. Mulch + Moderate Irrigation	127	88	95	36
6. Mulch + High Irrigation	104	113	79	59

Moderate amounts of water (irrigating each time there was a 60 percent reduction in available water) increased yields on sod grown trees during 1962 and 1963. More frequent application of water (irrigating each time there was a 40 percent reduction in available water) to the trees grown in sod resulted in decreased yields when compared to trees receiving the moderate levels of irrigation applied to trees that had been mulched also increased the yield in 1962 but not in 1963. Irrigating mulched trees in 1963 severely decreased yield irrespective of irrigation frequency. Mulch without irrigation increased the yield of Franklin trees both years, but had little effect on Richared trees.

The low yields obtained from irrigated trees in 1963 were not the result of a decrease in fruit size, but were closely associated with the influence of the 1962 treatments on flower bud formation and fruit set.

Although irrigation and mulch increased fruit size, the final size of the fruit harvested from the non-irrigated and non-mulched plots was considered good.

Trees with the most highly colored fruit were those grown under sod. Irrigation had little influence on the development of red color on the fruit during the 2 year period. Mulch, however, was very detrimental to the development of red surface color on the fruit.

More than 50 percent of the Franklin fruit harvested from mulched trees, irrespective of irrigation treatments, were classified as "green fruit" in 1963.

Fruit from the sod grown trees (without irrigation) were firmer at harvest than fruit from trees receiving the other treatments. Mulch without irrigation reduced the firmness of Richared fruit but not the Franklin fruit. Both levels of irrigation applied to either sod or mulched trees reduced fruit firmness when compared to fruit from the sod grown trees without irrigation.

Irrigation reduced the soluble solid (sugar) content of both Franklin and Richared fruit. The soluble solid content of the fruit from the mulched trees without irrigation was comparable to fruit from the sod grown trees without irrigation.

Mulch and irrigation treatments tended to increase the acid content of fruit. No controlled taste or flavor evaluations were made, but the decrease in soluble sugar and slight increase in acid content probably lowered the eating quality of the fruit.

Ohio Agr. Expt. Sta., Wooster, Ohio.

PLANT MANAGEMENT

Pasture and Haylands

SEE ALSO 27, 30, 36, 37, 43, 52, 62, 68, 73, 79, 87, 99, 101, 102, 112, 113, 115, 116, 117, 118, 119, 127, 137, 151, 153, 155, 213, 241.

144. Neumann, A. L. HAYLAGE COMPARED WITH HAY IN STEER RATIONS. Ill. Res. 6(1): 5. 1964.

Haylage is a term applied to a roughage feed harvested from the straight alfalfa or the legume-grass seedlings used in Illinois crop rotations. It is too wet for storage as hay but is drier than silage. Moisture levels of 30 to 50 percent are preferred.

Forage stored for haylage, like that stored for silage, undergoes fermentation. Spoilage losses are therefore excessive unless storage is in oxygen-free silos such as Harvestores or in very well-covered conventional silos in an excellent state of repair.

The feeding value of haylage for steers was tested during the winter of 1961-62. Forty yearling Hereford steers were fed from a starting weight of about 700 pounds to a final slaughter weight of about 1,100 pounds.

The haylage and hay were both third-cutting alfalfa from one field. The haylage, stored in a Harvestore, contained only about 27 percent moisture. It was of exceptional quality, however, analyzing 17 percent crude protein. The hay was of comparable quality and contained 14 percent moisture. Field-shelled, high-moisture corn was fed to all lots after being crimped upon daily removal from the Harvestore.

Each steer received 20,000 I.U. of preformed vitamin A daily, as well as a complete mineral mix fed free choice. Diethylstilbestrol was not used.

The 10 steers in each lot were slaughtered after the lot reached an average weight of about 1,100 pounds, and carcasses were evaluated.

Alfalfa haylage was more palatable than hay, it provided adequate protein for full-fed yearling steers, and it was a most acceptable roughage. Limited feeding of corn and protein supplement with a full feed of haylage was not satisfactory.

U. Ill., Col. Agr., Expt. Serv. Agr. and Home Econ., Urbana, Ill.

145. Martz, F. A., Campbell, J. R., and Merilan, C. P. COMPARISON OF SUPPLEMENTED FREE CHOICE CORN SILAGE RATIONS WITH OTHER FORAGE RATIONS FOR WINTERING DAIRY HEIFERS. Mo. Agr. Expt. Sta. Res. B. 853, 8 pp. 1964.

Corn silage has become a very important feedstuff for the ruminant dairy animal because of its high yield of forage per acre and its nutritional value. It is generally deficient in protein, calcium, and, possibly, vitamins A and D. Two feeding trials, each involving 40 Guernsey heifers, were conducted to gain more information concerning the supplementation of corn silage fed free choice to rapidly growing dairy heifers.

When 1.5 pounds of supplement C-2, a supplement containing soybean oil meal, alfalfa meal, molasses, dicalcium phosphate, vitamins and minerals, were fed to rapidly growing dairy heifers that were provided corn silage free choice, all animals made excellent winter gains.

The urea-containing supplement U-3 was not a satisfactory replacement for the soybean-oil-meal-containing supplement C-2 for a high corn silage ration when fed twice daily.

One important advantage of a well supplemented corn silage ration was the earlier freshening of heifers due to rapid growth. Earlier milk production resulted, with the possibility of a higher first lactation record due to better body conditioning, at the start of the lactation.

U. Mo., Agr. Expt. Sta., Columbia, Mo.

146. Jones, T. N., and Meredith, W. R., Jr. HIGHER FORAGE YIELDS WITH CLOSER ROW SPACING. Miss. Farm Res. 27(4): 4. 1964.

An experiment was started at State College, Miss., in 1962, to study the advantages of row spacing for forage crops. Four selected forages and seven row spacings were compared in a test that also involved two different rates of seeding and fertilization.

The forages selected were RS-610 (grain sorghum), FS-1A (grain sorghum), Dekalb sorghum and Pioneer corn. Row spacings included in the tests were 16, 20, 24, 28, 32, 36, and 40 inches.

The closer row spacings produced higher yields with all forages. The closer the spacing the greater the yield.

The narrow row spacings present a problem with equipment for seeding, cultivating, and harvesting forage. By proper use of pre-emergence chemicals, cultivation may be greatly reduced. The seeding may be accomplished with equipment now available if the row spacing is not less than 16 inches. However, harvesting presents a problem which requires additional research work.

Miss State U., Agr. Expt. Sta., State College, Miss.

147. Gaskin, T. A. EFFECT OF PRE-EMERGENCE CRABGRASS HERBICIDES ON RHIZOME DEVELOPMENT IN KENTUCKY BLUEGRASS. Agron. J. 56(3): 340-342. 1964.

The response of Merion Kentucky bluegrass as expressed by rhizome development and tiller number at two rates of Zytron, Dacthal, Bandane, Chlordane, and Crab-e-rad (calcium acid methyl arsonate) was determined. Zytron at 22.5 lb./A. greatly reduced rhizome length and number. At the 15 pound rate (standard) the reduction was less. Dacthal at 10 (standard) and 15 lb./A. reduced rhizome number and length as well as tiller number. Bandane at 40 pounds (standard) and Chlordane at 60 pounds (standard) did not cause injury while Bandane at 60 pounds and Chlordane at 90 pounds showed some reduction in rhizome number and length. Crab-e-rad, at 2.1 (standard) and 3.3 lb./A. greatly reduced the number of tillers and length of rhizomes and only at the 3.3 rate was there a reduction of rhizome number.

The Dwarf selection, tested with the standard rate of Zytron, Dacthal, Bandane, Chlordane, and Trifluralin (1.5 lb./A.), showed that Zytron and Dacthal reduced both number and length of rhizomes and number of tillers. Zytron also reduced the number of leaves. Trifluralin produced reduction in rhizomes and number of tillers. Bandane and Chlordane showed no injury.

Res. Develop., Warren Turf Nursery, Palos Park, Ill.

Rangelands

SEE ALSO 68, 152.

148. Dudley, R. F., and Hudspeth, E. B. PITTING AND LISTING TREATMENTS ON NATIVE SHORTGRASS RANGELAND. Tex. Agr. Expt. Sta. Prog. Rpt. 2312, 7 pp. 1964.

In the spring of 1958, replicated native grass plots at the Southwestern Great Plains Field Station, Bushland, Tex., were mechanically treated with a range pitter and a 2-row lister plow. Listing and pitting on a productive Pullman silt native grass range did not increase production during a 5-year period. Additional moisture was stored in the soil but was utilized by weeds during the first 2 years of the experiment. Seeding of Caucasian bluestem in the pits was not successful. The native grasses re-established in the pits during a 2-year period.

Results obtained during this study showed that pitting or listing was not economical for the 5-year period. However, the pits on both the listed and pitted plots are still very effective in impounding water, and they may prove to be of value in the future.

Tex. A&M U., Tex. Agr. Expt. Sta., College Station, Tex.

149. Nixon, E. S., and McMillan, C. THE ROLE OF SOIL IN THE DISTRIBUTION OF FOUR GRASS SPECIES IN TEXAS. Amer. Midland Nat. 71(1): 114-140. 1964.

The distributional patterns of Panicum virgatum L., Sorghastrum nutans (L) Nash, Andropogon scoparius Michx., and Bouteloua curtipendula (Michx.) Torr. include a number of soil types in central and eastern Texas. Of six soil types studied, two were calcareous, two were acid, and the remaining two were derived from serpentine and from granite. Clonal segments and seedlings grown on the soil types and subjected to certain nutrient elements showed that Panicum had a broad tolerance for the various edaphic conditions without evidence of being ecotypically differentiated. Andropogon plants from four areas showed a wide tolerance with slight selectivity in favor of calcareous soils. Andropogon plants from the acid pinewoods areas were susceptible to chlorosis on the calcareous soils, suggesting ecotypic differentiation due to edaphic conditions. Andropogon plants originating on calcareous soils were more tolerant than those from acid soils to high levels of calcium. Sorghastrum showed greatest response to serpentine and calcareous soils, but had a slight selectivity by some plants from acid soils for their native soils. Bouteloua plants, regardless of origin, grew best on the calcareous soils. A caespitose type of Bouteloua showed a selectivity for its native granitic soil and a rhizomatous type of Bouteloua showed a selectivity for its native calcareous soil. Both types of Bouteloua died when grown on acid soil from eastern Texas. Panicum virgatum, S. nutans, and A. scoparius, therefore, appear to have a wide tolerance for edaphic conditions with the exception of the eastern Texas populations of A. scoparius. The distribution of B. curtipendula is influenced, at least in part, by the presence of edaphic differentiation.

Plant Res. Institute, Dept. Botany, U. Tex., Austin 12, Tex.

150. Cornelius, G. L. COMPARISON OF ALTERNATIVE BEEF CATTLE SYSTEMS FOR WESTERN SOUTH DAKOTA RANCHES. S. Dak. Agr. Expt. Sta. Agr. Econ. Pam. 117, 15 pp. 1964.

A study was begun in 1959 in the range area of western South Dakota to determine the costs and returns of different sizes and types of commercial cattle ranch operations. A survey was made of 26 ranches from which budgets were developed for two sizes of ranches and four different types of cattle systems.

The smaller of the two ranches budgeted was defined as a one-man ranch requiring the labor and management of one man full time plus some additional seasonal labor. The larger ranch was defined as a two-man ranch requiring two men full time plus some additional seasonal labor. Size and income comparisons were made of these ranches operated with cow-calf systems.

The different types of cattle systems studied were budgeted only for the one-man ranch. These included cow-calf, fall sale; cow yearling, fall sale; cow-calf, spring sale; and stocker-steer operations.

Model budgets were developed for all ranches, assuming good ranch management. Net ranch returns were calculated at a number of different cattle sale prices.

The inventory value of the one-man, cow-calf ranch was \$133,280; the number of acres, 3,840; the number of brood cows, 147. The inventory value of the two-man, cow-calf ranch was \$300,583; the number of acres, 8,820; the number of brood cows, 335. At the cattle sale prices used, the net return to investment and management on the small ranch varied from 2.3 percent to a minus 1.2 percent. For the large ranch, the return to management and investment varied from 3.5 to a minus 0.2 percent.

Analysis of the different cattle systems showed the following:

1. When the price relationships among the different classes of cattle sold reflect long term average price differentials, the cow-calf, spring sale system had the highest net ranch income. Next highest was the stocker-steer system.
2. When the calves from the different systems were all sold at the same prices, the cow-calf, spring sale system and the cow-yearling system had approximately the same income. The income of the cow-calf, fall sale system was substantially below these two systems.
3. The stocker-steer system was the high profit-high risk system. When cattle prices were relatively high, the chance for profit was good even with a 4.5 cent drop in price from time of purchase to time of sale. When cattle prices were relatively low, the chances for the rancher earning a profit were better with any of the other systems.

Tables.

Agr. Expt. Sta., S. Dak. State Col., Brookings, S. Dak.

Plant Materials

SEE ALSO 171, 191, 198.

151. Joppa, L. R., and Roath, C. W. A COMPARISON OF KENMONT, ALTA, AND OTHER TALL FESCUE VARIETIES IN MONTANA. Mont. Agr. Expt. Sta. B. 582, 11 pp. 1964.

Five varieties of tall fescue were seeded at six dryland and four irrigated locations in Montana for determination of adaptation, yield, palatability, crude protein content, and stand establishment under saline soil conditions. Comparative data were obtained from only three of the dryland locations. All varieties tested lacked sufficient drought tolerance to maintain stands when grown on dryland where average annual precipitation was less than 12 inches for the first 2 years of the life of the stand.

Kenmont yielded significantly more than other varieties, with the exception of Alta, when grown under irrigation and produced higher mid-season yields than other varieties. Varieties did not differ significantly in crude protein content or palatability. However, Kenmont had the highest average palatability and crude protein content and was also superior to Oregon 4-36 and Goar in its ability to become established on saline soils.

Kenmont was recommended for use as an irrigated pasture grass in Montana on the basis of superior yield and equal or superior palatability and protein content.

Mont. Agr. Expt. Sta., Mont. State Col., Bozeman, Mont.

152. Ahring, R. M. THE MANAGEMENT OF BUFFALOGRASS (BUCHLOE DACTYLOIDES (NUTT.) ENGELM.) FOR SEED PRODUCTION IN OKLAHOMA. Okla. Agr. Expt. Sta. Tech. B. T-109, 20 pp. 1964.

The producer's method of harvesting buffalograss seed can make the difference between profit and loss. Seeds of most strains shatter readily upon maturity and during the process of harvesting. By comparing three methods of harvesting seed yields, it was found that a Gehl cutter most nearly harvested the actual amount of seed produced per acre. The Gehl cutter harvested the tops of the plants and at the same time created a suction force capable of picking up and delivering the shattered seed burs lying on the ground. By pulling a trailer behind the cutter and scalping immediately after harvest, this machine was used on a large scale with little seed loss. The other two methods investigated were: (1) Mowing and threshing; and (2) hand clipping and processing by hand.

Buffalograss produced two seed crops per year. The first, harvested in July, usually produced the major portion of the total seed produced. Under irrigation, the first crop produced an average of 500 to more than 1,000 pounds of seed burs per acre. The second crop, generally harvested in October, was usually light and of very poor quality.

Significant response to fertilizer was measured in 2 of the 4 years. Nitrogen applied at the rate of 60 lb./A. alone and in combination with 60 pounds actual phosphorus were the most effective treatments. The residual effect of the spring applications of fertilizer was not sufficient to meet the needs of the second crop for maximum production.

Without effective weed control practices, fertilization of buffalograss under irrigation was not practical. Light applications of 2,4-D effectively controlled broad-leaf weeds but, at the same time, seemed to stimulate the encroachment of annual grasses. Pre-emergence spray applications of simazine and diuron in April were effective in almost completely eliminating the annual grass competitors. Neither 2 nor 4 pounds active simazine per acre appeared to have any harmful or retarding effect on growth. An apparent lag in plant growth was observed in the area sprayed with the same amounts of diuron.

With an effective weed control program, heavy applications of fertilizers under irrigation were practical. However, in the areas fertilized with nitrogen alone a higher percentage of disease (false smut) was observed, particularly in the second crop. Application of 2,4-D at rates of 0.314 and 0.628 pounds acid per acre appeared to reduce the amount of infection and to stimulate seed-set.

The following management practices were recommended: (1) Establish a dense stand of buffalograss in ratio of approximately 1 to 10 male to female plants; (2) apply one pre-emergence spray application of 2 to 3 pounds of simazine per acre in early spring prior to fertilizing; (3) fertilize both first and second crops under irrigation with 60 to 80 lb./A. actual nitrogen either alone or in combination with 60 pounds of phosphorus; and (4) pay close attention to disease control, especially in the second crop. During the blooming phase of reproduction apply several applications of 0.157 pounds 2,4-D acid per acre.

Okla. State U., Expt. Sta., Stillwater, Okla.

153. Lawrence, T., and Ashford, R. SEED YIELD AND MORPHOLOGICAL DEVELOPMENT OF RUSSIAN WILD RYEGRASS AS INFLUENCED BY GRAZING. Canad. J. Plant Sci. 44(4): 311-317. 1964.

Removal of aftermath forage of Russian wild ryegrass (Elymus junceus Fisch.) by grazing increased seed yields by preventing the development of long mesocotyls which elevated the shoot apices to a height where they were subjected to frost damage. The sooner the grazing was started after the seed was harvested the higher was the seed yield in the subsequent year. Grazing prevented the decline in seed yield which normally occurs in ungrazed plants with increasing age of stand. Aftermath removal had no apparent effect on the stage of development achieved by the shoot apices just prior to freeze-up.

Observations showed that: (1) The protuberances on the apices start at the base and proceed by acropetal succession; (2) the transition from the vegetative to the reproductive phase of the apices takes place in the fall; and (3) a cold shock is not required to initiate the transition from the vegetative to the reproductive phase.

Expt. Farm, Canada Dept. Agr., Swift Current, Saskatchewan, Canada.

154. Hills, O. A. INSECTS AFFECTING SUGARBEETS GROWN FOR SEED. U. S. Dept. Agr. Handbook 253, 29 pp. 1963.

Sugarbeets grown for seed are subject to attack by various insects from the time the crop is planted in the late summer until the seed is harvested the following June or July. Without control, chewing insects often ruin stands soon after emergence of the plants, and sucking insects may so lower the vitality of the plants that little or no seed is produced.

The insects attacking the beet seed crop were described and illustrated under the following headings: Foliage feeders, seed feeders, and virus vectors.

ARS, USDA, Inform. Div., Room 645A, FCB, Hyattsville, Md., 20781

155. Lee, W. O. CHEMICAL CONTROL OF WEEDS IN CRIMSON CLOVER GROWN FOR SEED PRODUCTION. U. S. Dept. Agr., Agr. Res. Serv. Tech. B. 1302, 21 pp. 1964.

During 1957-61, nine experiments were conducted in western Oregon on controlling weeds in crimson clover (Trifolium incarnatum L.) grown for seed production. Five experiments dealt primarily with herbicides that were effective in controlling grass weeds and four experiments with herbicides that were effective for broadleaved weed control.

In the research on grass weed control, several herbicides were compared at different rates when applied at preplanting, preemergence, and several postemergence stages of plant development. CIPC and EPTC each at 6 lb./A. as preplanting soil-incorporated treatments and IPC at 4 lb./A. as a mid-winter postemergence treatment were the most promising. The midwinter postemergence IPC treatments showed slightly better weed control and were more consistent in increasing crimson clover seed yields than were the preplanting soil-incorporated treatments.

During the 3 years that IPC was applied at 4 lb./A. as a postemergence treatment, seed yields were increased about 200 lb./A. The average price paid to growers during this same period was 18.8 cents per pound. The average gross return on the increased seed yield amounted to about \$37.60 per acre. The cost of the chemical and application was about \$10 per acre.

In the research on control of hairy vetch (Vicia villosa Roth) and other broad-leaved weeds in crimson clover, various herbicides were compared at different rates when applied at several postemergence stages of development. MCPA at rates tolerated

by crimson clover gave the best overall weed control without reducing crimson clover seed yields. Rate of application and stage of development of both the crimson clover and the hairy vetch at the time of treatment were very critical in determining the degree of weed control and the effect of the herbicide on crop seed yields.

Crimson clover tolerated higher rates of MCPA without reduction in seed yield when the applications were made in December or February while the clover was in the rosette stage of growth. However, hairy vetch also tolerated these higher rates of MCPA during this early stage and control was poor. Hairy vetch became increasingly sensitive to MCPA as the season progressed. Best vetch control without clover seed yield reductions was obtained when MCPA was applied at 1/4 lb./A. between February 25 and March 15. Treatments made after March 15 gave excellent vetch control, but the likelihood of seed yield reductions increased as the clover approached the bud stage.

ARS, USDA, Inform. Div., Room 645A, FCB, Hyattsville, Md., 20781

Woodlands

SEE ALSO 2, 5, 51, 80, 89, 99, 100, 244, 245, 246, 254, 266.

156. Trimble, G. R., Jr. AN EQUATION FOR PREDICTING OAK SITE INDEX WITHOUT MEASURING SOIL DEPTH. J. Forestry 62(5): 325-327. 1964.

A regression equation for predicting oak site index from measurements of aspect, slope position, and slope percent was developed on three sandstone and shale soil series for the mountain province in West Virginia and a part of Maryland. Based on data previously used to develop a prediction equation from the above three factors plus total soil depth, this new equation, without the use of soil depth, provides for almost as accurate prediction. The necessary data for prediction can be collected much more easily because laborious soil-depth observations are not required. The close relationship between soil depth and the two topographic factors, slope position and slope percent, permits the elimination of soil depth from the estimating equation.

Northeastern Forest Expt. Sta., FS, USDA, Elkins, W. Va.

157. Richards, N. A., and Stone, E. L. THE APPLICATION OF SOIL SURVEY TO PLANTING SITE SELECTION: AN EXAMPLE FROM THE ALLEGHANY UPLANDS OF NEW YORK. J. Forestry 62(7): 475-480. 1964.

More than a decade has passed since it was realized that red pine, an excellent reforestation species for many sites in New York, was clearly unsuited to the imperfectly and poorly drained soils covering extensive portions of the Allegheny Uplands. However, this knowledge has yet to be effectively implemented in planting site selection.

This relatively simple example of the application of soil survey to forest planting site selection, red pine in the Allegheny Uplands of New York was discussed with particular emphases on relating the soil units of soil surveyors to forest planting site units. Red pine response to soil differences in this region were impressive, particularly when the economic implications of these differences were viewed. The most promising advances in site selection might be gained by better interpretation and use of published county surveys of the National Cooperative Soil Survey wherever available. The training of foresters and planting crew supervisors to recognize critical soil differences in their area was suggested both to improve control where adequate surveys are lacking and to supplement existing survey maps.

State U. Col. Forestry, Syracuse, N.Y.

158. MacConnell, W. P., and Kenerson, L. CHEMI-PRUNING NORTHERN HARDWOODS. J. Forestry 62(7): 463-466. 1964.

Chemi-pruning, a new term in American forestry, consists of deadening the lower branches of hardwood trees with chemical spray. The branches are then allowed to decay and drop off. Slash decay studies indicate that this should happen in 4 to 7 years when branches are 2 inches or less in diameter. Three spray mixtures applied with a shoulder-mounted mist blower killed branches to a height of 16 to 20 feet on tree stems. The technique proved safe for susceptible species like oak and was successful on resistant species like maple when used from mid-June to early September. Both 2,4,5-T and an invert emulsion of 2,4,5,-T and 2,4-D were used at costs ranging from \$5.10 to \$6.17 per acre. Chemi-pruning hardwoods is an economical method of improving tree quality which should increase the return from growing hardwoods.

U. Mass., Amherst, Mass.

159. Cumming, J. A. EFFECTIVENESS OF PRESCRIBED BURNING IN REDUCING WILDFIRE DAMAGE DURING PERIODS OF ABNORMALLY HIGH FIRE DANGER. J. Forestry 62(8): 535-537. 1964.

Six months after the highly destructive fires of April 20-21, 1963, a survey was made of previously prescribed burned areas in one New Jersey state forest and of untreated, adjoining, private forest land. Because of prior fuel reductions, areas prescribe-burned within the last 10 years supported 28 percent less fire of head intensity than the untreated areas. Damage in the untreated areas was markedly more—97 percent of the oaks and 70 percent of the pines killed or severely damaged, compared to 46 and 17 percent respectively in previously prescribe-burned areas. Even though prior fuel reductions, unless nearly complete, were not so effective as they would have been on more normal spring fire days, they did so reduce damage and intensity that expanded prescribed burning program recommendations have been substantiated.

N.J. Bur. Forestry, Trenton, N.J.

160. Worst, R. H. A STUDY OF EFFECTS OF SITE PREPARATION AND SPACING ON PLANTED SLASH PINE IN THE COASTAL PLAIN OF SOUTHEAST GEORGIA. J. Forestry 62(8): 556-560. 1964.

The results obtained from measurements of initial height growth and survival of slash pine (Pinus elliotii Engelm.) on various combinations of site, site preparation, and spacing, were given. A split-plot randomized block design of experiment was used. After four growing seasons, a complete measurement of all plots was made. From this measurement, statistical analyses were made of the two variables: (1) Average height of the "good" trees, and (2) percentage survival of all trees. From the analyses certain effects were made: (1) The effects of site preparation increased initial tree height growth and survival; (2) scalping, under the conditions tested was of questionable value; (3) the effects of site exhibited no trend in either height growth or survival from low to high sites; (4) there was no significant difference between plowed strips and solid harrowing; and (5) site preparation resulted in approximately 36 percent better height growth at the end of four growing seasons.

Brunswick Pulp & Paper Co., Brunswick, Ga.

161. Gregory, R. A., and Haack, P. M. EQUATIONS AND TABLES FOR ESTIMATING CUBIC-FOOT VOLUME OF INTERIOR ALASKA TREE SPECIES. U.S. Forest Serv. Res. Note NOR-6, 21 pp. 1964.

Total cubic-foot volume and merchantable cubic-foot volume inside bark for interior Alaska commercial tree species may be estimated using the equations or tables given. Diameter outside bark at breast height (D) and total height (H) are the field measurements needed to use these equations and tables for estimating volumes of white spruce (Picea glauca (Moench) Voss), aspen (Populus tremuloides Michx.), and cottonwood (P. balsampapyrifera Marsh.) trees were given. While the equations and tables were made primarily for use in growth and yield studies, they are also suitable for other uses such as timber sales, management plans, and forest inventory. The equations will be particularly useful when electronic computer facilities are available, allowing much more rapid and accurate volume estimates than could be accomplished with the tables alone.

Northern Forest Expt. Sta., FS, USDA, Juneau, Alaska.

162. Myers, C. A. VOLUME TABLES AND POINT-SAMPLING FACTORS: FOR LODGEPOLE PINE IN COLORADO AND WYOMING. U.S. Forest Serv. Res. Paper RM-6, 16 pp. 1964.

The tables presented give values needed to determine the volumes of lodgepole pines (Pinus contorta Dougl.) in Colorado and Wyoming. They provide timber cruisers and growth estimators with the following: (1) Gross volumes in total and merchantable cubic feet; (2) gross volumes in board feet, International 1/4-inch, and Scribner log rules; (3) point-sampling factors for merchantable cubic feet and board feet; and (4) distribution of board-foot volume among the logs of a tree. Volume on an area may be determined from: (1) Measurements of tree diameters and heights; (2) measurements of diameters and of sufficient heights to convert the appropriate volume tables to local volume tables; or (3) tree counts obtained by point-sampling.

Sample trees were measured in all major areas of commercial lodgepole pine in Colorado and Wyoming.

Rocky Mountain Forest & Range Expt. Sta., FS, USDA, Fort Collins, Colo.

163. Dahms, W. G. GROSS AND NET YIELD TABLES FOR LODGEPOLE PINE. U.S. Forest Serv. Res. Paper PNW-8, 14 pp. 1964.

Gross and net yields together with site index curves were presented for lodgepole pine on pumice soils for central and south-central Oregon. To obtain gross yields, gross volume increment was measured on 94 plots and by means of a multiple regression equation related to the stand variables age, site index, and stand density. Gross yield represents the cumulative summary of the increment equation obtained by integration with respect to age.

Pacific Northwest Forest & Range Expt. Sta., FS, USDA, Portland, Oreg.

164. Pase, C. P., and Pond, F. W. VEGETATION CHANGES FOLLOWING THE MINGUS MOUNTAIN BURN. U.S. Forest Serv. Res. Note RM-18, 8 pp. 1964.

In June 1956, a wildfire burned over approximately 18,000 acres of rough mountain land between Jerome and Dewey, Ariz. The fire began in a relatively open shrub live oak and skunkbush sumac area at 5,000 feet elevation, and stopped within the ponderosa pine type at 6,500 feet near the top of Mingus Mountain. The lower area was aerially seeded with weeping lovegrass; the higher area, above 6,000 feet, to both weeping lovegrass and crested wheatgrass.

Topography of the burned area consists of steep, hilly country at the lower end interspersed with numerous shallow, narrow valleys. Deep canyons, long, steep slopes with occasional benches, and mesas occur at the higher elevations.

On the lower area, the coarse soils are poorly developed, shallow, and are derived from granitic parent material. The finer textured, better developed soils, at higher elevations, are derived from shales, sandstones, and limestones, and contain considerably more organic matter.

Chaparral crown canopy and total shrub weights were still increasing six growing seasons after the wildfire on Mingus Mountain. Shrub live oak was the main component of the shrub community (68.0 percent) at that time.

Pointleaf and Pringle manzanitas and desert ceanothus plants were greatly reduced by the fire, but seedlings of these species were numerous within 5 years. Desert ceanothus seedlings outnumbered manzanite seedlings at the lower elevations (5,000 feet), but the reverse was true at higher elevations (6,500 feet).

Production of herbaceous species tended to be small except in one small area where shrub canopy was kept low by repeated chemical applications. On unsprayed plots, seeded and native grasses reached peak production in 1960, with about 200 lb./A. at the higher elevations and 60 lb./A. at lower elevations. On the sprayed area, production of weeping lovegrass alone exceeded 900 lb./A. in 1961. Production of forbs reached a peak during the second and third growing season after the burn, and then rapidly declined.

Grazing, by deer only in 1957-58 and by cattle and deer in 1958-59, was not excessive.

Rocky Mountain Forest & Range Expt. Sta., FS, USDA, Fort Collins, Colo.

165. Fahnestock, G. R., and Hare, R. C. HEATING OF TREE TRUNKS IN SURFACE FIRES. J. Forestry 62(11): 799-805. 1964.

Near the ground line, external heating of pole-size longleaf pines was essentially identical in headfires and backfires that consumed 8 tons of pine litter per acre; above 1 foot, temperatures were much higher in headfires than in backfires. At all levels, the leeward side of trees was heated more intensely than the windward side. Maximum and average temperatures usually were lower in bark fissures than on bark plates. Lethal cambium temperatures were recorded in some trees but not in others. Cambium injury occurred in streaks and spots and covered appreciable areas only on the leeward side of some trees burned in headfires.

Southern Forest Expt. Sta., FS, USDA, New Orleans, La.

166. Schimke, H. TESTS OF A WIND MACHINE AS AN AID TO BURNING SLASH. U.S. Forest Serv. Res. Note PSW-37, 5 pp. 1963.

Burning is one of the most economical methods of slash disposal, but climatic conditions in California make this procedure either unsafe or unsatisfactory much of the time. Conditions are often either too hazardous for burning or too wet to get a clean burn.

Tests of a wind machine as an aid to burning slash were conducted on the Stanislaus National Forest in California in the fall of 1962. The machine accelerated the burning process and enabled burning on otherwise impossible days. The time and manpower used in handling the machine and its cost made it an impractical substitute for conventional slash disposal methods.

Pacific Southwest Forest & Range Expt. Sta., FS, USDA, Berkeley, Calif.

167. Lotan, J. E. REGENERATION OF LODGEPOLE PINE: A STUDY OF SLASH DISPOSAL AND CONE OPENING. U.S. Forest Serv. Res. Note INT-16, 4 pp. 1964.

Two methods of slash disposal were tested using a randomized block design on the Langhor drainage (elevation 7,000 feet) of the Gallatin National Forest and the Dead-horse drainage (elevation 6,500 feet) of the Lewis and Clark National Forest. The treatments consisted of: (1) Piling green slash before it had been subjected to summer temperatures; and (2) piling slash that had dried for one summer. The slash was burned in the fall in each treatment. Using the stocked-quadrat method, seedlings on milacre plots were counted after the first, second, third, and seventh growing seasons.

Branches bearing serotinous cones of three age classes (1 to 2, 3 to 9, and 10+ years old) were placed on the ground and at 1-, 2-, and 3-foot heights above the ground on north and on south aspects. In the two study areas, six branches were placed at each height on both aspects; seed released from cones were caught in small wire screen baskets. To determine the effect on wire baskets on cone opening, 12 cones were placed 6 inches above square-foot seed traps on each study area—six cones in screen baskets and six without screens.

Two to three times as many lodgepole pine seedlings per acre were established when logging slash was piled green than when it was piled after drying for a summer. On the Lewis and Clark National Forest 22,175 seedlings per acre were established when slash was piled fresh and 10,475 when it was piled dry; the treatments yielded 7,067 and 1,967 seedlings, respectively, on the Gallatin National Forest.

Serotinous cones placed 1 foot or more above the ground did not open, whereas 40 and 83 percent of the cones placed directly on the ground opened on north and south slopes, respectively.

Intermountain Forest & Range Expt. Sta., FS, USDA, Ogden, Utah.

168. Boyd, R. J., and Deitschman, G. H. DEVELOPMENT OF YOUNG WESTERN WHITE PINE PLANTATIONS. U.S. Forest Res. Note INT-18, 6 pp. 1964.

Performance of western white pine in young plantations was markedly superior to that of natural stands. One reason for this superiority is that plantations become quickly established, whereas natural regeneration of western white pine stands may take many years. Second, the growth capabilities of the site are utilized by fewer, well-distributed trees. Other obvious advantages of plantations include easier application of cultural treatments and much greater control over species composition than can be achieved in natural stands.

The last periodic annual increment measurements differed by 50 percent between fair and excellent sites. This divergence demonstrated the importance of properly evaluating site quality before assigning area priorities for planting. Close spacing and consequent early stand closure quickly retard the average plantation tree. However, time for starting needed thinnings is provided by the apparent delay of adverse effects on the larger potential crop trees.

Higher stand densities resulted in slightly earlier mortality of lower crown portions. Since dead branches persist on western white pine for 50 years or more, early shading out of lower limbs probably would not improve wood quality significantly at harvest.

Intermountain Forest & Range Expt. Sta., FS, USDA, Ogden, Utah.

169. Shipman, R. D. LOW SEEDBED DENSITIES CAN IMPROVE EARLY HEIGHTS GROWTH OF PLANTED SLASH AND LOBLOLLY PINE SEEDLINGS. J. Forestry 62(11): 814-817. 1964.

Reduction in nursery bed density for slash and loblolly pine seedlings can result in significantly improved growth of field plantings. With systematic control of seed-bed density, both the morphological and physiological properties of southern pine seedlings can be altered. During the second growing season, loblolly and slash pine seedlings taken from low bed densities grew 5.1 and 3.3 inches taller, on the average than did seedlings produced at high bed densities. Both species after four growing seasons indicated that this growth differential between seedlings of low and high density beds had continued in favor of those grown at the lower densities.

School Forestry, Pa. State U., University Park, Pa.

170. Day, M. W. RESULTS OF A STUDY ON DIRECT SEEDING. Mich. Agr. Expt. Sta. Q. B. 46(3): 412-415. 1964.

Studies were made to determine the effectiveness of direct seeding of evergreen trees as a means of reforestation. Rough discing followed by direct seeding with any one of the species at the rate of 1/4 lb./A. of red pine seed, 2/10 lb./A. of jack pine seed, or 1/8 lb./A. of black spruce seed gave favorable results. Most favorable ground conditions were areas with light blueberry cover, and with no heavy grass.

Mich. State U., Agr. Expt. Sta., East Lansing, Mich.

171. Roe, E. I. HEAVY CROP OF RED PINE CONES YIELDS MANY THOUSANDS OF GOOD SEEDS. U. S. Forest Serv. Res. Note LS-36, 4 pp. 1964.

To add to the knowledge of seed production, a comprehensive study is being conducted in managed and natural stands and in two age classes, 50 and 90 years; a third age class, 120 to 140 years, has recently been added.

On the basis of one heavy seed crop, it was concluded that:

1. The amount of seed produced by red pine varied from about 16.1 lb./A. for a 90-year managed stand to 7.1 lb./A. for a 90-year natural stand. That from a 50-year managed stand, on the other hand, was only 1.6 pounds. Although total seed production appeared to be affected by stocking, this proved to be not significant.
2. The seed produced was of good quality in all stands, germination of the unfanned collections ranging from 82 to 89 percent. The 90-year managed stand bore 916,000 viable seeds per acre, the 90-year natural stand 370,000 seeds, and the 50-year managed timber 89,000 seeds.
3. Although half of the total amount of seed fell during the first month (October), some fell during the winter, and a significant amount also was shed during the spring and early summer months.
4. Seed soundness decreased as time elapsed, indicating that seed of the best quality fell first. However, enough viable seed fell during the spring and early summer months to be of considerable significance from the standpoint of regeneration cuttings.

Lake States Forest Expt. Sta., FS, USDA, St. Paul 1, Minn.

172. Scholz, H. F. SEEDING AND PLANTING TESTS OF NORTHERN RED OAK IN WISCONSIN. U.S. Forest Serv. Res. Paper LS-7, 7 pp. 1964.

A series of regeneration tests, involving direct seedings of northern red oak and out-plantings of 1-0 and 2-0 nursery stock of the same species, is in progress on the Hardies Creek Timber Harvest Forest in southwestern Wisconsin.

There were some depredations of acorns by rodents in direct seedings. These losses were reduced somewhat by protecting the seed spots with hardware-cloth cylinders. Eighty-one percent of the unprotected spots were stocked with one or more seedlings at the end of the first growing season, compared to 95 percent for screened spots.

Overtopping shrubs and herbaceous vegetation had an adverse effect upon seedlings and nursery stock. When this competing cover was cut back annually to within 2 or 3 inches of the ground, both the survival and total height of the released trees were better than on adjacent unweeded check strips.

During two out of nine winters, extensive damage was done to both seeded and planted northern red oak by rabbits and mice. Deer also nipped the tops of a few trees. While animal damage caused some mortality, its chief effect was to set the trees back for a year or two and reduce their average total height.

From these 10-year artificial regeneration tests, it was concluded that it is feasible to maintain northern red oak in the mixed-oak forest type by either direct seedings or by planting nursery stock, if natural regeneration provides inadequate.

Lake States Forest Expt. Sta., FS, USDA, St. Paul, Minn.

173. Barrett, J. W., and Holmsgaard, E. THINNING IN HARDWOODS—DANISH GUIDELINES FOR AMERICAN PRACTICES. J. Forestry 62(10): 716-720. 1964.

Thinning principles in hardwood stands have been developed through centuries of experience by Danish foresters. These principles furnish guidelines in the management of American species that are silvically similar. "Heavy" thinning is typical in hardwoods, but this adjective relates more to the frequency of the cut than to the amount of material removed.

The "critical" growing stock level in hardwoods is set at about 50 percent of the maximum that might exist with the species at a given age on the site. They are made necessary by the abundance of reproduction obtained in the regeneration of even-aged stands and the need to keep the best elements of the new stand in favored positions. Variations in thinning practices occur among forest districts and among species.

Four examples were presented to illustrate thinning intensities from light to heavy. Because of differences in silvical characteristics among beech, oak, maple, and ash, thinning practices with these species vary. These variations and their implications were mentioned.

U. Tenn., Knoxville, Tenn.

174. Carvell, K. L. IMPROVEMENT CUTTINGS IN IMMATURE HARDWOOD STANDS—YIELD INCOME WHILE INCREASING FUTURE SAWTIMBER VALUES. W. Va. Agr. Expt. Sta. B. 492, 17 pp. 1964.

A series of three improvement cuttings was made over an 11-year period on a 0.9 acre experimental plot on a cove hardwood site in northern West Virginia. These cuttings were designed to measure the effects of improvement cuttings on immature hardwood stands. The resulting data were compared with those from an adjacent untreated plot, used as a control.

After these cuttings, 354 trees per acre had been cut and sold. These cuttings left the straightest yellow-poplar dominating the stand. The number of red maple and poorly-formed oaks and black cherry was greatly reduced through cutting and through natural mortality between treatments.

The average diameter of all trees on the treated plot increased 2.9 inches during the 11-year period, while that of the control increased only 2.1 inches.

In the three improvement cuttings, a total of 7.8 cords was removed per acre. In spite of this drain, the standing cord volume at the end of the 11-year period was nearly similar on both plots.

A total income for the three improvement cuttings would vary from \$11.00 to \$15.00 per acre, depending on local market conditions. Combined with the increased future value of the stand, it should seem a profitable practice on forest land supporting cove hardwood stands.

As the markets for hardwood pulpwood and charcoal wood expand, stumpage prices will undoubtedly rise, and the attractiveness and use of improvement cuttings should increase rapidly.

Photograph.

W. Va. U. Agr. Expt. Sta., Morgantown, W. Va.

175. Tackle, D. REGENERATING LODGEPOLE PINE IN CENTRAL MONTANA FOLLOWING CLEAR CUTTING. U.S. Forest Serv. Res. Note INT-17, 7 pp. 1964.

Reports of a 10-year study in central Montana of stocking and density of regeneration on different kinds of seedbeds and on seed dispersal from standing timber were given. In each of 7 years, seed did not disseminate beyond 3 chains (about 200 feet) into clear cuttings in quantities sufficient for reproducing a stand. Usually about two-thirds of the total number of seeds released in a year fell during the period October to June.

After 10 years, no significant changes in density or stocking were apparent except on burned seedbeds, which were adequately stocked but not overstocked; other seedbeds were overstocked. New recommendations for slash disposal to meet different management objectives were discussed.

Intermountain Forest & Range Expt. Sta., FS, USDA, Ogden, Utah.

176. Schallau, C. H. FOREST OWNERS AND TIMBER MANAGEMENT IN MICHIGAN. U.S. Forest Serv. Res. Paper LS-9, 39 pp. 1964.

Management of forest land in Michigan varies considerably among ownership classes. At one extreme are the owners of small privately owned woodlands who, for the most part, are passive producers of timber. At the other extreme are the managers of many large tracts who assume positive roles in producing and marketing timber products. Outdoor recreational values are assuming greater importance as a motive for land managers. Extremes in management of forest land are reflected in the level of timber production. Output from private lands has been decreasing while the cut from public forests is increasing. The latter, which as late as 1940 did not contribute much to the State's timber cut, accounted for approximately 24 percent in 1960.

Photograph, maps, tables, and charts.

Lake States Forest Expt. Sta., FS, USDA, St. Paul, Minn.

177. Goodyear Aerospace Corporation. BALLOON LOGGING SYSTEMS PHASE I. ANALYTICAL STUDY. Contract 19-25. 109 pp. 1964.

A major forestry problem in western North America is that of harvesting timber from difficult terrain without impairing other multiple use values of the forest resource. The problem is complicated by the increasing need to protect and improve the water, recreational, and forage values of these lands.

Millions of acres of timberland in western United States, Canada, and Alaska have been bypassed as being economically inoperable by established methods of logging. These lands are characterized by steep slopes, moderate-to-low stand densities, and soil conditions that make roadbuilding difficult and costly.

A study for the Forest Service by the Goodyear Aerospace Corporation, established the mechanical feasibility of employing a lifting balloon secured, in effect to a log(s) to be yarded by a cable system immediately adjacent. As a result, less of the log weight rests on the ground, the front end of the log is elevated, and less effort is required to drag the load. Use of a balloon permits downhill log yarding over considerable distances without the necessity of erecting other means to elevate the log ends. This was a parametric study that analyzed the effects of various balloon types (spherical, blimp shaped, and VEE BALLOON), sizes, windspeeds, terrain, grades, temperatures, altitudes, and balloon angles and effects of butt rigging heights on net log lift, cable loads, and power requirement.

The study was concerned with only the engineering aspects of balloon logging and did not review the economics of the concept.

Pacific Northwest Forest and Range Expt. Sta., FS, USDA, Portland, Oreg.

178. Goodyear Aerospace Corporation. BALLOON LOGGING SYSTEMS PHASE II. LOGISTICS STUDY. Contract 19-25, 171 pp. 1964.

During this phase of the over-all program, an operational concept was established; and the required ground support equipment, personnel, cycle times, and other economic and logistic factors were examined for each of the systems. The cycle times were analyzed parametrically as functions of payload, ground slope, yarding distance, and yarder output horsepower for dragging the logs with tension in the main cable during haul-back. The effects on cycle times of flying the logs and removing main cable tension during haul-back were calculated. From a comparison of cycle times, costs, payload capabilities, and handling features for each of the balloon systems, it was found that both static-lift and dynamic-life balloons could be used economically for logging.

Because of the importance of cycle times and payload in an economic evaluation, the dynamic-lift balloon showed greater possibilities for cost reduction. Therefore, it was recommended that a dynamic-lift-type balloon be used in the follow-on program for full-scale field tests to evaluate completely the potential of commercial balloon logging systems.

Pacific Northwest Forest and Range Expt. Sta., FS, USDA, Portland, Oreg.

179. Bernstein, D. A. A TEST OF STAND AGE ESTIMATION FROM AERIAL PHOTOS IN EVEN-AGE DOUGLAS-FIR. Photogrammetric Engin. pp. 242-245. March 1964.

Stand age is needed for forest management planning in even-aged Douglas-fir. The possibilities of obtaining stand age from aerial photos were explored. A formula for determining stand age, using photo-measured tree heights and crown closure, was

developed. In a test of the formula on 20 even-aged stands, only 7 were correctly placed in their proper 20-year age class. It was concluded that using aerial photos to determine stand age was impractical.

Div. Timber Mangt., Pacific Northwest Region, FS, USDA, Portland, Oreg.

180. Heller, R. C., Doverspike, G. E., and Aldrich, R. C. IDENTIFICATION OF TREE SPECIES ON LARGE-SCALE PANCHROMATIC AND COLOR AERIAL PHOTOGRAPHS. U. S. Dept. Agr. Handbook 261, 17 pp. 1964.

Research conducted near Ely, Minn., in July 1960, indicated the best film and scale combination for identifying tree species. These results should be applicable to: Inventories of timber; assess damage to forests by destructive enemies; appraise forest wildlife habitat; and expedite forest administration.

Color film was superior to panchromatic film for use in identifying individual tree species.

Value and chroma data derived from the color transparencies were plotted as they would be on a Munsell chart. While the differences in value among species are still small on color film, by adding another variable—chroma—greater separation between species can be seen.

According to the Munsell notation, hue or color can be represented by 100 equally spaced increments of a hue circuit beginning with 1 red and ending with 10 red purple.

There is a wide spread in hue and chroma among the conifers; pines have more chroma than fir and spruces, and white pine averages three hues greener than red or jack pine. Of the hardwoods, red maple was consistently recorded with the strongest chroma, while trembling aspen was greener than red maple or white birch.

The frequency of hues observed by photo interpreters for each species exhibited a definite central error. However, the upland spruces and balsam fir had a rectangular distribution of hue (7.5YR to 2.5G) caused by spruce budworm feeding damage of foliage of these species. Various degrees of budworm feeding caused foliage to change from green through yellow to red brown (YR). Thus, the hues can be correlated with the degree of damage that occurred. In the absence of defoliation, the normal hues for these species were found to be greener than when all degrees of defoliation were included.

The slight range of hues for each species may be attributed to two factors: (1) A normal variation in hue within tree species; and (2) an actual physiological difference in the receptivity of human eyes.

Accurate identification of individual tree species requires color film at a photoscale of 1:1584 or larger. Even on color film, the 1:3960 scale produced fairly low accuracies of interpretation (63 percent).

The cost of using color film at large scales should be little more than that required for panchromatic film. While color film costs five times as much as panchromatic film, film cost was only a small part of the total cost of aerial photography.

Tree species were identified accurately enough on color film at large scales to suggest the possibility of using it on actual inventory problems.

Charts, tables, and photographs.

FS, USDA, Inform. Div., Washington, D.C., 20250

181. Brown, J. H. EFFECT OF TIME OF SUMMER PRUNING ON BUD SET, LIMB DEVELOPMENT, AND SHOOT GROWTH OF SHEARED PINES. W. Va. Agr. Expt. Sta. B. 498, 33 pp. 1964.

Pruning or shearing of pines was of great importance to produce high quality Christmas trees. Scotch pine, red pine, and white pine were pruned at six separate intervals during the summer months over a 6-year period.

For Scotch pine and red pine the maximum numbers of buds were formed after mid-June shearings, with the number declining as later trimmings were used. For white pine, maximum numbers of buds were formed after shearings made in early-July, with the number declining rapidly as mid-July or August prunings were used. For Scotch pine, numbers formed on trimmed stems were greater at all times than the numbers of unpruned controls. For red and white pines, only those trees pruned in June or July formed greater numbers of buds than were formed on unsheared trees.

The total number of limbs formed usually followed patterns similar to those shown by bud formation.

The number of effective limbs formed varied only slightly. For Scotch pine, maximum numbers occurred after early-June prunings with the number decreasing steadily as later shearings were used. With red and white pines, this trend was modified slightly, with even numbers or a slight build up in June, followed by a steady decline in July and August. In the case of white pine, usually no limbs formed after mid-August prunings. For Scotch pine, numbers of effective limbs were greater than the numbers of effective limbs on unpruned trees, regardless of time of shearing.

Shoot growth followed a pattern quite similar to that for effective limb formation, except that for all three species maximum growth occurred on early-June pruned stems, and growth declined steadily on those sheared later.

Early-June sheared Scotch and red pines had approximately 85 to 90 percent as much growth as unpruned trees, whereas white pine trimmed at the same time had only about 65 percent as much growth as did unpruned trees. In mid-July, these values were about 65 percent for Scotch pine and less than 50 percent for red and white pine. Mid-August values were 36 percent for Scotch pine, 17 percent for red pine, and only 0 to 5 percent for white pine.

The principal factors which could modify the patterns discussed are seasonal differences in growing conditions and significant changes in latitude and/or altitude from those of the areas utilized in these studies.

Pruning at different levels on the trees produced differences in results. Maximum bud set, limb development, and shoot growth originated from shearings on the terminal, with equal results from prunings on the two topmost whorls (but fewer numbers or less growth than on the terminal). Fewer buds and less growth occurred after pruning on the third whorl of limbs. If a narrow, conical outline is desired, prune fairly heavily on the upper whorls, with somewhat less shearing on lower whorls. If the broad outline is desired, less trimming is needed on upper whorls.

First prunings on trees produced more buds and limbs than any of the succeeding prunings on the same trees. These differences were greatest for bud formation and somewhat less for total and effective limb formation. Scotch pine showed the greatest increase in numbers after first prunings when compared with later ones, followed by red pine and then white pine.

The ratio of length of new needles on developing shoots to length of old needles on the previous year's terminal was a reliable indicator of early-season growth patterns. In early-June, average lengths of new needles on Scotch pine were approximately one-half of those of old needles. Similar early-June ratios for red and white pines were approximately one-third those of old needles.

Tables, graphs, and photographs.

W. Va. U. Agr. Expt. Sta., Morgantown, W. Va.

182. Day, M. W. THE EFFECTIVENESS OF SEVERAL CHEMICALS AND METHODS FOR KILLING CULL TREES. Mich. Agr. Expt. Sta. Q. B. 46(3): 407-411. 1964.

Several chemical formulations of 2,4-D and 2,4,5-T as esters and amines were applied to aspen, red maple, white pine, and alder to determine their killing effectiveness as a possible culling method. The hatchet and oil can method and a tree injector were used in making the applications. Concentrated 2,4-D amine gave good results with aspen by either method if the distance between gaps was kept to 1 inch. Red maple required full strength 2,4,5-T amine or concentrated ester in edge-to-edge cuts. Alder had 100 percent kill by all methods used, and white pine was somewhat more resistant to treatment than aspen.

Mich. State U., Agr. Expt. Sta., East Lansing, Mich.

183. Offord, H. R. DISEASES OF MONTEREY PINE: IN NATIVE STANDS OF CALIFORNIA AND IN PLANTATIONS OF WESTERN NORTH AMERICA. U.S. Forest Serv. Res. Paper PSW-14, 37 pp. 1964.

Seventy two pathogens occurring on Pinus radiata D. Don were described and a brief background of the native host and its environment was given. Records of pathogens in California herbaria, pathology notes in Forest Service files, findings of recent surveys, and publications provided the basis for an index of these pathogens. An appendix listed 86 additional pathogens on exotic Monterey pine. For each pathogen the known world-wide distribution was given.

Photographs, tables, and maps.

Pacific Southwest Forest & Range Expt. Sta., FS, USDA, Berkeley, Calif.

184. Merkel, E. P. HYDRAULIC SPRAY APPLICATIONS OF INSECTICIDES FOR THE CONTROL OF SLASH PINE CONE AND SEED INSECTS. U.S. Forest Serv. Res. Paper SE-9, 7 pp. 1964.

Field spray tests were conducted from 1959-61 in north Florida to evaluate the effectiveness of hydraulic spray applications of BHC, Guthion, and DDT for the control of coneworms (Dioryctria spp.) and the slash pine seedworm (Laspeyresia anaranjada). Slash pines up to 40 feet in total height were protected from coneworm attack with BHC (4 lb. gamma isomer/100 gal. water) or Guthion (1.5 lb./100 gal. water). DDT (4 lb./100 gal. water) did not give satisfactory protection from coneworms. Of the three tested, Guthion was the only insecticide which controlled the seedworm. A spray schedule was given for the control of coneworms and the seedworm on slash pine in north Florida.

Southeastern Forest Expt. Sta., Asheville, N.C.

185. Lemmien, W. A., and Rudolph, V. J. ECONOMIC AND SILVICULTURAL ASPECTS OF ROW AND BASAL AREA THINNING PLANTED RED PINE. J. Forestry 62(10): 721-723. 1964.

Row thinnings in planted red pine, removing every other row, every third row, and every fourth row, were compared to residual basal area thinnings leaving 70, 90, 110, and 130 square feet per acre, as to time required per cord of pulpwood removed and residual stand quality. Row thinning required significantly less time per cord of wood removed, with the largest difference in required time occurring in the felling operation. The most severe row thinning (removing every other row) retained 178

excellent potential crop trees per acre, while in the other row and basal area treatments, the number of excellent trees increased proportionately as the residual stand increased. Row thinning deserves consideration for use in initial thinning in suitable planted red pine stands.

W. K. Kellogg Expt. Forest, Augusta, Mich.

186. Payne, B. R. TRENDS IN REFORESTATION AND ITS COST IN THE PACIFIC NORTHWEST. U.S. Forest Serv. Misc. Paper 11 pp. 1964.

Serious commercial efforts at artificial reforestation in the Pacific Northwest began in 1915 with the planting of 2,500 acres. In 1962, nearly 205,000 acres were reforested, 102,000 by direct seeding and 103,000 by planting. The total cost of reforestation in 1962 was \$7-1/2 million, an average of \$37 per acre.

In contrast to the expenditure for seeding and planting, one-third of a million dollars was spent for reforestation research in 1961.

Approximately 255,000 acres of commercial forest land are denuded each year by clear cutting and by fire in immature timber. In addition, there is a backlog of about 2 million unstocked acres. A reasonable annual reforestation goal probably should be at least 250,000 acres.

Existing nursery and seed extraction capacity may impose a limit on expansion of the reforestation effort. There are several large areas which present unusually difficult reforestation problems and are not likely to be reforested until more successful and economical methods of seeding or planting are developed.

The reforestation effort should be concentrated on those acres which provide an acceptable return on their reforestation cost.

Tables.

Pacific Northwest Forest & Range Expt. Sta., FS, USDA, Portland, Oreg.

Windbreaks

187. Stoeckeler, J. H. DESIGN OF SHELTERBELTS: FOR AGRICULTURAL LANDS IN RELATION TO MICROCLIMATE AND IMPROVED SOIL EROSION CONTROL. World Crops 16(4): 20-21. 1964.

Data and a review of the literature were presented on the role of shelterbelts in reducing wind velocity, erosion, and evaporation and improving microclimatic conditions to increase crop yield.

Shelterbelts have been used extensively in Western Europe, USSR, Canada, and USA. Some examples of the types of tree and shrub used in these countries were given. In many developing countries, shelterbelts will be planted on an increasing scale, not only as a method of soil conservation, but as a source of nuts, fruit, timber, and fuel wood.

As a means of controlling wind erosion, a wind barrier that provided 39 percent reduction of the wind at 10 tree heights to leeward showed only 0.1 percent movement of sand in relation to open conditions. At 20 tree heights, the movement was only 18 percent. Barriers reduced wind velocity 20 percent or more to a distance of 15-25 tree heights to leeward. To a distance of 10 tree heights, the reduction may be 30 percent or more. Some reduction to windward also occurs.

Belts should be fairly dense, but if they are too dense excessive turbulence is created nearby. Wind reduction efficiency must be weighed against other factors, such as the area occupied, the area sapped or shaded by it, the cost of establishment, and the value of woodland products. Pruning may have to be used to reduce excessive density.

Shelterbelts increase moisture by trapping snow and decreasing evaporation. However, the real value is in areas where there is no snow and where conditions range from semi-arid to subhumid. Here they make the limited supply of soil moisture more effective in crop production by lowering the water requirements of the plants by reducing the weight of water required to produce an equal weight of dry matter from the crop.

Shelterbelts increase temperature slightly, which may improve the growth rate of some crops, and increase condensation and dew fall. The microclimate effects are generally favorable for crops, but may not be so under excessive heat.

Lake States Forest Expt. Sta., FS, USDA, St. Paul, Minn.

Fruit and Nut Crops

SEE ALSO 51, 70, 72, 79, 91, 134, 141, 143, 216.

188. Dodge, J. C., and Snyder, J. C. GROWING STRAWBERRIES IN WASHINGTON. Wash. Inst. Agr. Sci. Ext. B. 346, 19 pp. Rev. 1964.

A complete "culture and care" publication was given for growing strawberries in Washington.

Wash. Agr. Expt. Sta., Inst. Agr. Sci. Wash. State U., Pullman, Wash.

189. Turrell, F. M., Monselise, S. P., and Austin, S. W. EFFECT OF CLIMATIC DISTRICT AND OF LOCATION IN TREE ON TENDERNESS AND OTHER PHYSICAL CHARACTERISTICS OF CITRUS FRUIT. Bot. Gaz. 125(3): 158-170. 1964.

The evaporating power of the air and air temperature increased progressively from coastal, intermediate, and interior in desert citrus-growing districts. Moisture contents of peel, pulp, and whole fruit of Washington Navel and Valencia oranges, grapefruit, and lemons decreased progressively for the several districts from the cool moist coastal district to the hot dry desert district, whereas the peel puncture pressures increased. Fruit picked from the tops of trees had lower moisture contents and higher peel puncture pressures than fruit picked from the bottoms of the trees. The generally observed tenderness of citrus fruit growing in the coastal district to rind-breakdown, water rot, oil spot, sunburn, fumigation, oil sprays, and storage was correlated with low peel and pulp dry-matter contents and low peel puncture pressures; these relationships were best expressed by the multiple correlation coefficient ($r = +0.9898$) between peel puncture pressure, evaporation, and the reciprocal of peel moisture as percent of dry peel.

U. Calif. Citrus Res. Cent., Riverside, Calif.

190. Porritt, S. W. THE EFFECT OF TEMPERATURE ON POSTHARVEST PHYSIOLOGY AND STORAGE LIFE OF PEARS. Canadian J. Plant Sci. 44(6): 568-579. 1964.

Response of Anjou and Bartlett pears to nine storage temperatures ranging from 29° to 70° F. was determined by periodic evaluation of ripened fruit, analysis of certain chemical and physical properties, and measurement of respiration throughout the storage period.

After harvest, low metabolic activity persisted about 4 days in Barlett and over 50 days in Anjou at 50° to 70° F. Anjou pears ripened only after a period of cold storage. The total amount of carbon dioxide respired during storage life diminished with rising temperature. Storage life of Anjou and Bartlett pears was respectively 35 and 40 percent greater at 30° than at 32° F.

Res. Station, Canada Dept. Agr., Summerland, British Columbia, Canada.

191. Ritter, C. M., and McKee, G. W. THE ELDERBERRY: HISTORY, CLASSIFICATION, AND CULTURE. Pa. Agr. Expt. Sta. B. 709, 22 pp. Mar. 1964.

The elderberry represents a rather large group of neglected fruits. There are at least 20 species of elderberry (*Sambucus*) which grow in the north temperate and subtropical regions of the world. Four edible species are found in North America.

They hybridize easily. Breeding and selection should develop new varieties of useful and nutritious fruit.

The elderberry fruit has a high vitamin C content—usually equal to citrus and only slightly less than that of black currant.

The elderberry is readily adaptable to a wide variety of environmental conditions. Research at the Pennsylvania State Agricultural Experiment Station demonstrated that high yields (average of 4 to 6 tons per acre) could be realized under a system of nitrogen fertilization and shallow cultivation sufficient to control weed growth.

At least nine varieties of elderberry are available for commercial use. These plants may be used to develop a commercially profitable fruit crop on land not well suited to other forms of agriculture—such as strip-mine spoil banks and imperfectly drained soils.

Tables and photographs.

Pa. State U., Col. Agr., Agr. Expt. Sta., University Park, Pa.

192. Ogawa, J. M., Boyack, G. A., Sandeno, J. L., and Mathre, J. H. CONTROL OF POST-HARVEST FRUIT DECAYS IN RELATION TO RESIDUES OF 2,6-DICHLORO-4-NITROANILINE AND DIFOLATAN. Hilgardia 35(14): 365-373. 1964.

Field spray applications in 1961 on peach and apricot indicated lasting residual activity of DCNA under the California environment of high temperature with no rain, and high activity of residual DCNA against *Rhizopus stolonifer* with 1 and with 0.5 pound of DCNA in 100 gallons of water. Some activity against *R. stolonifer* was observed with 1 pound of captan and of folpet. DCNA activity was comparable with that of captan and folpet on *Monilinia fructicola* on peach and usually apricot.

Field sprays in commercial peach orchards during 1962 showed that three sprays of DCNA were more effective in control of *Rhizopus* rot peaches than were one or two sprays when peaches were subsequently ripened in chambers held at 20° C. and 80 percent relative humidity. When treatments resulting in similar DCNA residues at harvest were compared, consistent reduction of *Monilinia* rot was shown only with the three spray applications. Dip treatments with Halford peaches showed control of *Rhizopus* rot with a residue of 4 p.p.m. DCNA and of *Monilinia* rot with a residue of a mixture of 28.4 p.p.m. DCNA and 13 p.p.m. Difolatan.

Residue analyses of field-sprayed peaches indicated the average half-life of DCNA to be about 6 days (half of original residue was present) under the arid environment of California when sprays were applied approximately 4 weeks before harvest.

Following canning, the peaches showed trace amounts of DCNA, but Difolatan could not be detected by the method of analysis used.

Tables.

Agr. Pub., University Hall, U. Calif., Berkeley, Calif.

Field Crops

SEE ALSO 26, 27, 30, 31, 32, 33, 34, 35, 38, 39, 48, 61, 62, 71, 74, 76, 77, 79, 81, 82, 83, 84, 85, 90, 96, 102, 103, 104, 105, 106, 107, 108, 109, 112, 113, 116, 120, 121, 122, 123, 124, 126, 128, 129, 132, 135, 137, 141, 142, 145, 154, 218, 223, 226, 230, 231, 232, 234, 235, 242.

193. Middleton, G. K., Hebert, T. T., and Murphy, C. F. EFFECT OF SEEDING RATE AND ROW WIDTH ON YIELD AND ON COMPONENTS OF YIELD IN WINTER BARLEY. Agron. J. 56(3): 307-308. 1964.

Three varieties of winter barley were grown in both 8 and 16-inch rows at three rates of seeding in the row. Yield and the following components of yield were studied: (1) Number of heads per unit area; (2) the weight of seed from 100 heads; (3) weight of seed per 1000 kernels; and (4) the weight per bushel.

Decreasing the rate of seeding decreased the number of fertile heads per unit area but increased the number of seeds per head as measured by the weight of grain per 100 heads. The weight of 1000 seed and test weight per bushel were not affected significantly.

There was no significant difference in yields in 8- and 16-inch rows or at the different rates of seeding. These data indicate that under good to optimum conditions a larger total increase may be expected from a limited supply of breeder's or foundation small grain seed by using wider rows or thinner than normal seeding rates, with little if any decrease in yields. Seeding on less fertile soils or at later than optimum dates might make this practice questionable.

Jr. Author, N.C. Agr. Expt. Sta., Raleigh, N.C.

194. Burnside, O. C., and Colville, W. L. YIELD COMPONENTS AND COMPOSITION OF SOYBEANS AS AFFECTED BY MECHANICAL, CULTURAL, AND CHEMICAL WEED CONTROL PRACTICES. Agron. J. 56(3): 348-351. 1964.

Ford soybeans were grown on irrigated and non-irrigated land during 1961-62 to determine the effect of mechanical, cultural, and chemical weed control practices on 14 characters affecting soybean yields.

Those characters showing a positive correlation (0.01) with soybean yields were plant height at maturity, lodging, weight of 100 seeds, seed-bearing nodes, number of pods, and number of seeds per plant. Characters showing a negative correlation (0.01) with soybean yields were weed yields, height of lowest pod, bushel weights, and oil percentage of seed.

Tillage, amiben at 2 and 4 lb./A. wide row spacings, and irrigation reduced the height of the lowest pod on soybeans which may increase combine harvest losses.

Tillage treatments as compared to untilled plots increased soybean yields, plant height at maturity, seed-bearing nodes per plant, number of pods per plant, and number of seeds per plant; and decreased weed yields, lodging, height of lowest pod, and protein percentage. Other characteristics were not significantly affected by tillage treatments.

Narrow row spacings increased soybean yields and plant population; and decreased weed yields, seed-bearing nodes per plant, number of pods per plant, number of seeds per plant, bushel weight, and germination percentage.

The weed control treatments of hand-weeding and amiben at 2 and 4 lb./A. increased soybean yields, plant height at maturity, seed-bearing nodes per plant, number of pods per plant, number of seeds per pod, number of seeds per plant, and oil percentage; and decreased weed yields, lodging, height of lowest pod, and protein percentage.

U. Nebr., Lincoln, Nebr.

195. Harris, V. C. PRODUCTION OF COTTON WITHOUT POSTEMERGENCE CULTIVATION OR HAND HOEING. Miss. Agr. Expt. Sta. B. 685, 7 pp. 1964.

Annual weeds were satisfactorily controlled in non-cultivated cotton by a broadcast application of a preemergence and postemergence herbicide.

The cost of weed control by herbicides without cultivation was \$3.41 less per acre than the cost of weed control by cultivation and hand-hoeing. Weed control with herbicides without cultivation returned \$6.58 more per dollar invested in weed control than cultivation plus hand-hoeing.

Cotton weeded with pre- and post-emergence herbicides without cultivation produced 572 lb./A. more seed cotton than that weeded with cultivation and hand-hoeing. The non-cultivated cotton plants fruited earlier and withstood drought longer than the cultivated cotton plants.

Mean yields and mean net returns per acre for 13 years of weeding with herbicides with no cultivation were significant at the 1 percent level of probability when compared to the weeding with cultivation and hand-hoeing of cotton.

Miss State U., Agr. Expt. Sta., State College, Miss.

196. Norden, A. J. RESPONSE OF CORN (ZEA MAYS L.) TO POPULATION, BED HEIGHT, AND GENOTYPE ON POORLY DRAINED SANDY SOIL. I. ROOT DEVELOPMENT. Agron. J. 56(3): 269-273. 1964.

The root response of two hybrid corn varieties to plant populations and bed heights on a poorly drained sandy soil (Leon fs) was studied at Gainesville, Fla., in 1960-61.

A split plot design with 2 hybrids (Coker 811 and Florida 200) and 5 plant populations (5,000, 10,000, 15,000, 20,000, and 25,000 plants per acre) as the subplot treatments were used. The whole-plot treatments consisted of beds of four different settled heights (0 or ground level, 3, 6, and 9 inches). Beds were constructed over the entire plot area by tractor-mounted disk plows forming ridges or single row beds, 38 inches apart. The various bed heights were then produced by lowering each ridge to the pre-assigned level.

Plant population had the greatest effect on corn root development. The dry weight of roots per plant decreased 72 percent by increasing the plant population from 5,000 to 25,000 plants per acre while width and depth of root clump were decreased by 14 and 33 percent respectively. On a per acre basis, however, the yield of dry roots increased with increasing populations to 20,000 plants per acre. Increasing the plant population above 20,000 to 25,000, plants per acre resulted in a significant 9 percent decrease in yield of roots per acre for the 2-year period.

A positive curvilinear effect between bed height and dry weight of roots was obtained in 1960, a season characterized by a high water table. A non-significant positive relationship was also obtained in the drier, 1961 season. Depth of root clump was significantly greater on the bedded plots than on the level plots in 1961. Bed height had no significant effect on width of root clump in either season.

The root systems of the different hybrids did not respond uniformly to the various populations and height of beds or to the different seasons.

Fla. Agr. Expt. Sta., U. Fla., Gainesville, Fla.

197. Herbert, L. P. CULTURE OF SUGARCANE FOR SUGAR PRODUCTION IN LOUISIANA. U.S. Dept. Agr. Handbook 262, 40 pp. 1964.

A complete "culture and care" publication was given for growing sugarcane in Louisiana.

ARS, USDA, Inform. Div., Room 645A, FCB, Hyattsville, Md., 20781

198. Broadhead, D. M. EFFECTS OF STRIPPING AND STORAGE ON SUGARCANE SIRUP PRODUCTION. Crop Sci. 4(2): 180-181. 1964.

The sugarcane variety C.P. 36-111 produced excellent sirup without removing the leaves from the stalks. Stripped and unstripped stalks produced the same quality and yield of sirup.

C.P. 36-111 was stored unprotected in the fall up to 28 days in Mississippi without a loss in yield or quality of sirup. Sirup color was improved and sucrose crystallization was prevented by storage. The cost of evaporating the juice to sirup density decreased with time in storage.

Miss. Agr. Expt. Sta., CRD, ARS, USDA, Maderian, Miss.

199. Shaw, L., Gossett, D. M. RATE OF SEEDING IN BURLEY TOBACCO PLANT BEDS AS IT AFFECTS STAND DENSITY, NUMBER, AND TYPE OF TRANSPLANTS PRODUCED, AND FIELD PERFORMANCE. N.C. Agr. Expt. Sta. Tech. B. 159, 26 pp. 1964.

The emergence and performance of burley tobacco seedlings in plant beds at seeding rates of 1/32, 1/16, 1/8, 3/8, 1/4, 1/2, 5/8, 3/4, and 1 ounce of seed per hundred square yards were studied in experiments at Waynesville, N.C., from 1954-58. Field performance of transplants produced from the seeding rates of 1/16, 1/4, and 3/4 ounce was studied from 1956-61.

1. The number of plants which emerged increased as the seeding rate was increased; however, the percent of seed producing seedlings decreased as the seeding rate was increased.
2. The number of plants suitable for transplanting in each of the three pullings increased as the seeding rate was increased up to about 1/2 ounce per hundred square yards. Seeding rates from 1/2 to 1 ounce per hundred square yards resulted in very small differences in yield of plants suitable for transplanting.
3. The green weights of the tops and roots of the transplants decreased very rapidly as the seeding rate increased from 1/32 to 3/8 ounce per hundred square yards. The decrease was more gradual with increase in seeding rates above 3/8 ounce.
4. Higher seeding rates resulted in only a slight increase in the over-all length of the above-ground portion of the plants; however, the main stems of plants from the more densely seeded beds were definitely longer.
5. Increasing the plant-bed seeding rate from 1/32 to 1 ounce per hundred square yards resulted in a decrease in transplant survival in the field. Blooming date in the field was delayed as plant stand density in the plant bed was increased.
6. Yields and acre values were higher on plots transplanted from plant beds seeded at the lower seeding rates than on plots transplanted from beds seeded to produce more dense stands.

7. A plant-bed seeding rate of 1/4 ounce per hundred square yards led to the production of a substantial and economical number of desirable transplants that performed well in the field. Seeding rates lower than 1/4 ounce produced stockier but fewer transplants that performed well in the field. However, the plants were difficult to transfer to the field with mechanical transplanters. Seeding rates higher than 1/4 ounce did not substantially increase the yield of transplants during the normal transplanting period (2 weeks). As the rate of seeding was increased, transplants became progressively spindlier, more vulnerable to the shock of transplanting, and slower in establishing themselves in the field, and the field tobacco was later in maturing, lower in yield of cured leaf, and lower in acre value.

Agr. Expt. Sta., N.C. State Col., Raleigh, N.C.

200. LaPrade, J. L., Petty, J. G., and Willis, W. H. USE OF PLASTIC FILM IN PRODUCTION OF TOBACCO SEEDLINGS. Va. Agr. Expt. Sta. Tech. B. 167, 12 pp. 1964.

The comparative effects of plastic and cheesecloth seed bed covers on tobacco seedling production were studied over a 2-year period.

Use of plastic in combination with cheesecloth gave better results than either covering used alone. Best results were obtained when this combination covering was placed horizontally over the seed bed approximately 4 inches above ground level. This treatment raised the average minimum soil temperature 11° F. above that of the soil in the cheesecloth-covered check bed, and 5° F. above that of the bed covered with the plastic film placed on an "A" type wood frame with the apex 24 inches above ground level. The maximum average soil temperatures for the three treatments were 90°, 75°, and 81° F., respectively, for the principal growth period.

Seedlings were ready for field transplanting 6 weeks after seeding in the bed covered with the combination of plastic and cheesecloth, but 9 weeks were required to produce plants of similar size under the flat covering of cheesecloth alone. Under this combination cover, seed germinated in less than 2 weeks, while approximately 3 weeks were required for germination under cheesecloth alone.

Va. Agr. Expt. Sta., Va. Polytech. Inst., Blacksburg, Va.

201. Tingey, D. C. CONTROL OF GROUNDCHERRY. Utah Agr. Expt. Sta. B. 444, 14 pp. 1964.

Effects of combination treatments involving winter wheat, spring barley, field corn for silage, and sweet corn for canning, grown continuously and in rotation, with and without commercial fertilizer, and combined with six cultural and herbicidal treatments on the control of groundcherry and on crop yield were reported.

It was not possible to measure any detrimental effect on groundcherry on crop yields except in 1953 and 1955 on silage corn, when the yields were about 9 percent higher on areas of light density than on those of medium or high density.

Groundcherry was controlled when any of a number of different combination treatments were continued for 4 or 5 years. Growing either winter wheat or spring barley combined with plowing as soon as the crop was harvested and cultivation at 2- to 3-week intervals during the remainder of the season were some of the most practical and effective treatments. Winter wheat used for weed control should be planted early in September into a moist seedbed. From 80 to 125 pounds of nitrogen should be applied per acre broadcast in late fall or early spring. The soil should be kept moist by irrigation until the grain begins to change from green to straw color.

Spring barley should be planted early in a moist seedbed. From 80 to 100 pounds of nitrogen should be applied per acre and the land irrigated and cared for the same as for wheat.

Corn for silage or sweet corn for canning may also be used when combined with cultivation between rows and 2,4-D or 2,4,5-T at 1 lb./A. sprayed along the row under the corn leaves. Nitrogen at the rate of 100 to 150 pounds to the acre should be applied and the corn irrigated enough to keep it in a thrifty condition. These crops can also be used in a rotation program.

Tables, graphs, and photographs.

Agr. Expt. Sta., Utah State U., Logan, Utah.

202. Molberg, E. S., Friesen, H. A., McCurdy, E. V., and Dryden, R. D. PLACEMENT OF DI-ALLATE AND TRI-ALLATE FOR CONTROL OF WILD OATS IN WHEAT. *Canad. J. Plant Sci.* 44(4): 351-358. 1964.

Two years of field trials at a number of sites in Western Canada showed that selective control of wild oats in wheat with di-allate or tri-allate was feasible if the seed was planted 3 in. deep and the chemicals incorporated shallowly after seeding. The most reliable and practical means of achieving this placement of the chemical was by harrowing immediately after application. Harrowing twice resulted in slightly better wild oat control than harrowing once, but this did not increase crop yields. At one site, in 1962, under conditions of excessive moisture and late seeding, there was severe injury to wheat. However, even here the injury was less with the post-seeding than with the pre-seeding method. There was some evidence that wheat was more tolerant to tri-allate than di-allate. Pre-seeding incorporation with the disk gave slightly better weed control than post-seeding incorporation with a double harrow, but again differences were not great enough to affect yield.

Expt. Farm, Canada Dept. Agr., Regina, Saskatchewan, Canada.

203. Dupree, M. INSECTICIDAL AND CULTURAL CONTROL OF THE LESSER CORNSTALK BORER. *Ga. Agr. Expt. Sta. Mimeo. Ser. N. S.* 197, 21 pp. 1964.

Seedlings of southern peas and other legumes suffer stand losses by attacks of the lesser cornstalk borer. This injury is most conspicuous in the summer when the young plants are killed by larvae that are denied their natural food when weed host plants are plowed under in land preparation for immediate planting. Heavy damage is often encountered in legume plantings made on small grain stubble.

Infestations were low during May and June. During July they increased rapidly and reached the seasonal peak in mid-August.

Chlorinated hydrocarbon insecticides reduced borer infestations. Where infestations were moderate to heavy, stand protection was often significant. Aldrin, BHC, DDT, dieldrin, heptachlor, and toxaphene in the form of granules, dusts, and liquids reduced the number of seedlings killed when applied in bands of different widths along the row.

Land kept free of weed hosts for a period of time (8-10 weeks) before planting resulted in the most effective borer control. Insecticides in combination with this practice were of no benefit. Significant control with insecticides was obtained in the series where weeds grew until planting time and infestations were heavy. All insecticides reduced the number of borer-killed plants significantly. However, fewer plants were killed in the untreated area of the clean-fallow series than in the most effective insecticide treatment of the weed grown area.

When only the two tillage practices without insecticides were compared, a significant reduction in borer-killed seedlings resulted on land kept clean of weed growth for a period of time before planting.

The length of time land was kept free of weeds was longer than necessary to gain benefits. The greatest amount of damage to seedling peas in late summer was caused by nearly mature larvae which had developed on some other plants.

Two or three weeks of fallowing could be beneficial in reducing borer population if weed growth is completely destroyed in the first operation and if the land is kept clean until it is planted.

Ga. Agr. Expt. Sta., Athens, Ga.

204. Lukefahr, M. J., Noble, L. W., and Martin, D. F. FACTORS INDUCING DIAPAUSE IN THE PINK BOLLWORM. U.S. Dept. Agr., Agr. Res. Serv. Tech. B. 1304, 17 pp. 1964.

Laboratory and field studies conducted at Brownsville, Tex., indicated that diapause in the pink bollworm (Pectinophora gossypiella (Saunders)) was controlled primarily by photoperiod, with boll age and temperature exerting a secondary effect.

Photoperiods progressively increasing from 12 to 16 hours and a constant photoperiod of 14 hours favored the development of nondiapause larvae, whereas decreasing photoperiods and constant ones above and below 14 hours were effective in inducing larvae to enter diapause. Parental effect on the F₁ progeny was also expressed in the progeny's response to photoperiod. Diapause was induced when the parents emerged in a photoperiod longer than that in which the progeny developed.

Larval response to a mean temperature of 70° F., compared with 81.5° F., partially overcame the response to photoperiod. This effect of reduced temperature, which induced diapause, was found to take place in the first and second instars.

The incidence of diapause larvae in bolls infested after the bolls were 20 days old increased with age of the boll. This response to boll age, found to be independent of photoperiod, undoubtedly was due to a progressive change in nutrition of the boll.

It was concluded that the diapause habits of the pink bollworm largely determined the insect's distribution and seasonal abundance.

ARS, USDA, Inform. Div., Room 645A, FCB, Hyattsville, Md., 20781

205. Whitcomb, W. H., and Bell, K. PREDACEOUS INSECTS, SPIDERS, AND MITES OF ARKANSAS COTTON FIELDS. Ark. Agr. Expt. Sta. B. 690, 84 pp. 1964.

Brief discussions of each of the following major and minor pests of cotton grown in Arkansas were given: Boll weevil; boll worm; spider mites; trips; cotton fleahopper; tarnished plant bug; cotton aphid; and cotton leafworm.

Approximately 600 species of predaceous arthropods were found associated with cotton. They represented 45 families of insects, 19 families of spiders, and 4 families of mites. During the growing season, natural enemies of the boll weevil were of little consequence. However, insecticide applied against the boll weevil often upset the vital predator control of bollworms and spider mites.

The green jacket dragonfly destroys large numbers of bollworm, cabbage looper, and cotton leafworm moths. Grasshoppers and crickets are good predators. Green lacewing larvae are among the most efficient predators. The insidious flower bug, big-eyed bugs, and nabids include some of the best known predators of the cotton field. The greatest number of predaceous species were found among the beetles (120 species). Outside of the large families of Diptera, comparatively little work has been done in Arkansas cotton fields on predaceous flies. The predatory habit is strongly developed in the Hymenoptera. Ants attack the bollworm and the boll weevil from egg to adult. The extreme diversity in habits of the various species of wasps proved to be of practical value.

All spiders are predaceous and supposed to be beneficial. There is not a single pest of Arkansas cotton that is not attacked by one or more species of spiders. However, they also feed freely on beneficial insects. Four families of predaceous mites are known to be present in Arkansas cotton fields.

To determine the efficiency of bollworm egg predators, bollworm eggs were placed in a cotton field at the rate of approximately 85 eggs per 100 plants or 125,000 eggs per acre. After 24 hours, the number of bollworm eggs per 100 plants dropped from 84.6 to 52.9. To determine the fate of the missing eggs, 531 predator feeding observations were made. Ants carried away 119 eggs. Lady beetles destroyed 307 eggs.

Very few predators move directly from overwintering quarters to cotton as they usually pass the first few generations on early crops or weeds. Alfalfa, wheat, corn, Johnson grass, and sorghum are also excellent sources of predators.

Careful timing of insecticide application can help prevent excessive destruction of predators with broad-spectrum insecticides. Insecticides should be applied only when pest insects are present in destructive numbers.

Choice of insecticides that would kill destructive insects only has limited potential for boll weevil and bollworm control but has possibilities against the cotton aphid, thrips, and plant bugs.

Tables, graphs, photographs, and bibliography.

Agr. Expt. Sta., Div. Agr., U. Ark., Fayetteville, Ark.

206. Brady, H. A. TOXIC AND NON-TOXIC LEVELS OF ATRAZINE ESTABLISHED FOR CROPS. Pa. Sci. Farmer 11(4): 8. 1964.

Widespread use of persistent herbicides for weed control on tolerant crop species has led to occasional damage to susceptible crops.

Atrazine is an effective, persistent herbicide against all plant species except corn but its persistence may result in damage to succeeding crops. Toxic levels in the soil have been determined for a number of common crop species.

Oats and soybeans are the common agronomic crops most likely to be damaged. These crops show leaf burning and chlorosis from the presence of 0.40 lb./A. of atrazine.

Oat and soybean seedlings were killed when there was from 0.90 to 1.00 lb./A. of atrazine present in the soil.

Legume seedlings started to show damage when the atrazine level in the seeding zone reached 0.80 lb./A. and the seedlings of all common agronomic species except corn were damaged when the level was over 1.00 pound.

Although toxic levels of atrazine in the soil are established, there is still no quick, easy test available to determine if these levels are present. The safest procedure is to apply atrazine as recommended and plant crops the following year that are not highly susceptible to it.

Atrazine gets out of the soil primarily by leaching as rainwater filters downward. Soil microorganisms, bacteria, and fungi, break down atrazine slowly and chemical reactions between the herbicide and other chemicals in the soil do occur but both these methods of removal are minor compared to the first. Fortunately, all three work together. Management to improve the first also increases the others. Good farming—that maintains the organic matter content at a favorable level, prevents loss of topsoil by erosion, maintains high fertility, and assures optimum pH by liming when it is required—favors removal of excess atrazine from the seedling zone of the soil.

Pa. State U., Col. Agr., Agr. Expt. Sta., University Park, Pa.

207. Hatch, R. E., Tefertiller, K. R., Moore, D. S., Rogers, R. H. PRODUCTION AND PRODUCTION REQUIREMENTS, COSTS AND EXPECTED RETURNS FOR COTTON, GRAIN SORGHUM AND MAJOR FRESH MARKET VEGETABLE CROPS ON CLAY SOILS—LOWER RIO GRANDE VALLEY OF TEXAS. Tex. Agr. Expt. Sta. MP-694, 47 pp. 1964.
208. Moore, D. S., Tefertiller, K. R., Hughes, W. F., and Rogers, R. H. PRODUCTION AND PRODUCTION REQUIREMENTS, COSTS AND EXPECTED RETURNS FOR CROP ENTERPRISES ON MEDIUM-TEXTURED (MIXED) SOILS—HIGH PLAINS OF TEXAS. Tex. Agr. Expt. Sta. MP-695, 70 pp. 1964.
209. Hatch, R. E., and Moore, D. S. PRODUCTION AND PRODUCTION REQUIREMENTS, COSTS AND EXPECTED RETURNS FOR COTTON, GRAIN SORGHUM AND MAJOR FRESH MARKET VEGETABLE CROPS ON LOAM SOILS—LOWER RIO GRANDE VALLEY OF TEXAS. Tex. Agr. Expt. Sta. MP-719, 55 pp. 1964.

These three publications gave the costs and expected returns for different crops and soils in regions in Texas listed.

Tex. A&M U., Tex. Agr. Expt. Sta., College Station, Tex.

210. Gerlow, A. R., Mullins, T., and Campbell, J. R. ENTERPRISE COSTS AND RETURNS: SOUTHWESTERN LOUISIANA RICE AREA. La. Agr. Expt. Sta. D.A.E. Res. Rpt. 335, 90 pp. 1964.

With rapid changes occurring in technology, institutional factors, etc., farmers are in constant need of production data which will aid them in determining optimum management systems for their farms. Input-output and costs-returns data were developed for the rice enterprise using two planting methods (drill and water planting), on three soil groups, and two farm sizes. Production practices and income levels were shown for present technology (current practices and associated returns) and for advanced technology (improved practices recommended by the experiment station and their associated returns). Information was also developed in budget form for row crops such as corn, cotton, soybeans, and sweetpotatoes, but only for the soil groups which had adequate internal drainage suitable for their production. The information on row crops was also for two levels of technology and two farm sizes.

Tables.

La. State U. & Agr. & Mech. Col., Agr. Expt. Sta., University Station, La.

Vegetable Crops

SEE ALSO 26, 62, 66, 71, 74, 79, 86, 105, 123, 124, 125, 141, 207, 209, 223.

211. Gavett, E. E. TRUCK CROP PRODUCTION PRACTICES: SAN JOAQUIN COUNTRY, CALIFORNIA; LABOR, POWER, AND MATERIALS, BY OPERATION. U.S. Dept. Agr., Econ. Res. Serv., Farm Prod. Econ. Div. ERS-166, 50 pp. 1964.
212. Gavett, E. E. TRUCK CROP PRODUCTION PRACTICES: MARION COUNTY, OREGON; LABOR, POWER, AND MATERIALS, BY OPERATION. U.S. Dept. Agr., Econ. Res. Serv., Farm Prod. Econ. Div. ERS-169, 35 pp. 1964.

These two publications contain information on labor requirements, production practices, and costs involved in the production of truck crops for fresh market and processing for the areas stated.

Tables, graphs, and maps.

MOS, USDA, Inform. Div., Washington, D.C., 20250

213. App, J. L., Pulver, G. C., Schmidt, J. R., and Schoenemann, J. A. VEGETABLE ENTERPRISE SELECTION IN CENTRAL WISCONSIN. Wis. Agr. Expt. Sta. Res. B. 247, 23 pp. 1964.

The most profitable combination of vegetable crop enterprises in the Central Sand Plain of Wisconsin was determined. The study was limited to growers who receive most of their income from irrigated vegetable crops and who sell all vegetables for processing except potatoes.

Linear programming was used to determine the optimum vegetable crop enterprises under varying resource conditions. On the basis of survey questionnaires, typical resource situations were established with representative variations in farm size, investment capital, and management levels. Cost and return information was developed through a series of approximations of what producers could do if they followed Experiment Station recommendations. This information was validated by empirical data and farmer interviews.

Potatoes, cucumbers, snap beans, sweet corn, peppers, tomatoes, and field corn were studied.

Potato rotations in the Central Sand Plain were the most profitable vegetable crop programs for the commercial vegetable growers. The 2-year rotation of potatoes and rye was the most profitable.

Potatoes and rye remained most profitable under wide price ranges of alternative vegetable crops. Tomatoes were the only other vegetable crop which could be included in the most profitable cropping program.

Cropland and investment capital were the limiting resources in the analysis. In two-thirds of the situations where investment capital was limiting, additional investment capital would return the growers 93 to 113 percent for each additional dollar invested. In the other cases where cropland was limiting, acquiring additional cropland would return \$198 to \$241 for each additional acre.

The next most profitable vegetable crop program (excluding potatoes) consisted of 5 acres of tomatoes, 5 acres of peppers, and the remaining resources in snap beans. This combination returned less than one-third the returns possible from the potato-rye rotation.

Vegetable growers should concentrate on their decision-making as to what vegetable crops to grow. If the grower lacks knowledge as to the resource requirements, resource costs, prices of output and returns from each unit of vegetable enterprise, he can suffer serious income penalties.

Tables.

Agr. Expt. Sta., U. Wis., Madison, Wis.

214. Minton, W. H., and Byers, G. B. LABOR, OTHER COSTS, AND MANAGEMENT PRACTICES IN PRODUCING AND MARKETING SNAP BEANS IN SOUTHEASTERN KENTUCKY. Ky. Agr. Expt. Sta. B. 687, 22 pp. 1964.

Snap beans are one of the more important vegetables as a consumer item. The per capita consumption of snap beans in the United States has remained about 7-1/2 pounds per person for the last 20 years. Recently there has been a shift toward frozen beans as a processed item.

The following farm management problems of snap bean production were studied: (1) Cost and returns for both production and marketing; (2) market organization for the snap bean enterprise; (3) harvesting labor supply factors; (4) yield relationships to fertility levels and plant population; (5) time and motion aspects of the picking methods and equipment used; and (6) economic feasibility of mechanizing the harvesting of snap beans in Kentucky.

The economic analysis of snap bean production showed the gross returns to range from \$327 to \$524 per acre, with an average of \$447 per acre. The total cost varied from \$258 to \$436, or an average of \$365 per acre. The difference between cost and income left net returns to land and management varying from \$69 to about \$88 per acre with an average of \$82 per acre.

A study of the organization of the snap bean enterprise indicated the following two types of contractual relationships being used by the growers: (1) The farmer agreed to produce an acreage of snap beans and use the Growers Exchange as a marketing agency; and (2) cash expenses, land preparation, planting, cultivating, and spraying operations were shared by the Growers Exchange and the farmer with net returns being divided equally between the two parties. Both fresh and processing markets were utilized as sales outlets. The sales policy has been to avoid the hazards of consignment within the fresh market channel and to use the fresh market only in relation to specific orders.

Fertility levels and plant population effects upon the snap bean yields were studied on an experimental basis with total yields adjusted in relation to percent of marketable beans. The 5 plants per foot and the 400-pound level of 10-10-10 fertilizer gave the most profitable returns.

Peak labor requirements for the snap bean enterprise occurred at harvesting time. Picking time per bushel of snap beans varied indirectly with yield per acre. Three picking procedures were studied by motion and time methods. In general, for yields of less than 100 bushels per picking, the basket and bag method proved more efficient; with yields over 100 bushels, the self-emptying cart proved to be more efficient.

The harvesting cost accounted for about two-thirds of the total cost of production. Increasing labor costs have encouraged bean producers to consider the possibility of mechanizing the harvesting operation. A budgetary analysis of mechanical harvesting costs with one picking per crop indicated that a yield of about 86 bushels per acre would be required in order to return as much to land and management as the hand method of harvesting where three pickings per crop were obtained. A combined method of hand picking the first harvest, followed by mechanical picking of the second harvest, would have increased the land and management returns for the 1960 crop from \$82 to \$119, using the actual first and second hand picking yields of 78 and 85 bushels, respectively. This total of 163 bushels compared with the realized yield of 223 bushels under the usual method of hand picking three times. The combination of hand and machine picking also indicated a larger return to land and management on the acre basis.

Tables and graphs.

U. Ky., Agr. Expt. Sta., Lexington, Ky.

215. Halstead, R. L., and Gfeller, F. THE COOKING QUALITY OF FIELD PEAS. *Canad. J. Plant Sci.* 44(3): 221-228. 1964.

In a greenhouse study with two varieties of field peas, the cooking quality of the Weitor 702 (a good-cooking pea) was markedly influenced by P and K additions and by the initial fertility level of the soil. The cooking quality of Kapuskasing remained poor regardless of treatment or fertility level of the soil. Ash and total inorganic, and phytin P content of the pea samples tended to increase with addition of P fertilizer. Correlation coefficients expressing the relationship between cooking quality and chemical constituents of the pea seeds indicated that cooking quality varied with ash and phytin P content.

In field studies, soil properties (pH and available P) were not related to cooking quality or chemical properties of peas grown at different locations. Although cooking quality, phosphorus content, and cation content of the pea samples varied according to variety and location, there was no significant relationship between cooking quality and the chemical constituents.

The cooking quality of F₂ and F₃ seed from a Weitor 702 X Kapuskasing cross varied, but was not related to the chemical properties of the peas.

Soil Res. Inst., Canada Dept. Agr., Ottawa, Alberta, Canada.

216. Shuffett, D. M., and Burnett, B. J. ACREAGE VARIABILITY AND SEASONAL PRICE PATTERNS IN THE KENTUCKY COMMERCIAL VEGETABLE AND STRAWBERRY INDUSTRY. Ky. Agr. Expt. Sta. B. 690, 20 pp. 1964.

The commercial vegetable industry in Kentucky has been characterized by instability in both production and prices. Acreage used for commercial vegetable production appears to have leveled out since 1950, but strawberry production has continued to decline.

Kentucky has considerable potential for vegetable production owing to location, soil, and climate, particularly for supplying local markets. The State is a deficit area for commercial truck crops, and markets are currently supplied from outside areas for most crops.

An important factor influencing the vegetable industry in Kentucky appears to have been the attitudes of farmers toward commercial vegetables. Traditionally, Kentucky has been a tobacco-livestock producing state, and producers have hesitated to move into horticultural enterprises even when opportunities appeared to be present.

It was believed that much of the instability in the commercial vegetable industry in the State stems from variability in prices received for products. Seasonal price variability was analyzed for six of the commercial truck crops produced in greatest volume in Kentucky. Prices followed definite patterns during the harvesting and marketing season for each of the commodities. Income from a crop could have been more than doubled during most years by selling when prices were seasonally high compared with the low periods.

Weather is an important determinant of when a crop matures and is ready for market, but the altering of varieties, planting dates, and cultural practices may enable producers to take advantage of known price patterns.

Tables, graphs, and maps.

U. Ky., Agr. Expt. Sta., Lexington, Ky.

217. Shands, W. A., and Landis, B. J. POTATO INSECTS: THEIR BIOLOGY AND BIOLOGICAL AND CULTURAL CONTROL. U.S. Dept. Agr. Handbook 264, 61 pp. 1964.

The biology and brief descriptions of insect pests of Irish potatoes were presented as a reference for agricultural workers who are responsible for suggesting control measures. With more than 100 known pests of potatoes in this country, it is essential that the pests most commonly found in each production area be recognized and their life histories and habits known. This information will be useful not only in advising growers when to use insecticides but also in suggesting alternatives or supplemental cultural and biological control measures, including maximum utilization of natural enemies.

Photographs and drawings.

ARS, USDA, Inform. Div., Room 645A, FCB, Hyattsville, Md., 20781

ECONOMIC AND SOCIAL ASPECTS OF SOIL AND WATER CONSERVATION

Costs and Returns

SEE ALSO 1, 2, 39, 118, 131, 132, 144, 145, 148, 150, 174, 178, 185, 207, 208, 209, 210, 214, 248.

218. McElroy, R. C., Hecht, R. W., and Gavett, E. E. LABOR USED TO PRODUCE FIELD CROPS: ESTIMATES BY STATES. U.S. Dept. Agr. Statis. B. 346, 43 pp. 1964.

The estimates of farm labor requirements given were part of a continuing nationwide research program centered on agricultural production. The program includes the development and maintenance of many measures of farming efficiency.

The report contains national estimates for selected periods, 1800 to 1963, of the man-hours of labor used per acre and per unit of production of the major field crops. Comparable State estimates from the agricultural census were presented for 1959.

The periodic State estimates were weighted into regional averages which serve as benchmarks for annual series. Each year the regional averages of man-hours per acre of field crops, together with comparable data for fruit and other crops and per head or unit of production of livestock, are applied to the estimates of acres, numbers, and production of crops and livestock, prepared by the Federal-State crop reporting system to arrive at total man-hours of labor used by enterprises, for regions, and for the country as a whole. The total man-hours are converted to indexes which, together with comparable indexes of production, are used to compute indexes of production per man-hour. The aggregate man-hours are also used as the labor component in an index measure of total production inputs in farming. These aggregates and indexes are published annually by the Economic Research Service in Charges in Farm Production and Efficiency, Statistical Bulletin 233.

Tables.

MOS, USDA, Inform. Div., Washington, D.C., 20250

219. Frisby, J. C., and Hull, D. O. FARM CUSTOM RATES FOR 1964. Iowa Farm Sci. 18(7): 8-9. 1964.

Cost figures on various farm operations based on cost accounting records of Iowa State University were given in a condensed table.

The rates listed were based on normal working conditions and do not include labor. They include only actual cost with no margin for profit or risk and are not intended for commercial operations.

Agr. and Home Econ. Expt. Sta., Iowa State U. Sci. and Tech., Ames, Iowa.

220. Ihnen, L., and Heady, E. O. COST FUNCTIONS IN RELATION TO FARM SIZE AND MACHINERY TECHNOLOGY IN SOUTHERN IOWA. Iowa Agr. Expt. Sta. Res. B. 527: 125-155. 1964.

Estimates of average costs per dollar of crop product were made for five machinery combinations and for crop acreages varying from 40 to 640 acres on three different soil mixtures in the Shelby-Grundy-Haig soil association area. These three soil mixtures were referred to as hilly, average, and upland farms. Cropland, as a proportion of total land, increased from approximately 30 percent on the hilly farm to 70 percent on the upland farm. Two budgeting models were considered. In model I, only cropland was considered. In model II, pasture production marketed through a beef-cow enterprise was considered along with cropland. Changing from model I to model II had relatively little effect upon the basic budgeting results or cost relationships.

A schedule of the time during which each crop operation can be performed without yield loss and a schedule of the time required for each field operation were derived for each crop. Revenue and yield reductions from crop field operations performed after scheduled time periods also were considered for each crop. A high efficiency level, high fertilization rates, specific field operations for each crop, and rotations containing the highest proportion of row crops consistent with suggested soil conservation standards were assumed in each budgeting model.

The budgeting analysis suggested that substantial reductions in average total cost per dollar of crop product could be obtained by using larger machinery combinations on larger crop acreages when custom operations were not considered. Unit cost declined rapidly as crop acreage increased, and minimum unit cost was achieved at about 320 crop acres on each farm. Since the proportion of cropland in the three soil mixtures differed widely, the total land required to achieve minimum unit cost ranges from 1,061 acres on the hilly farm to 453 acres on the upland farm. The budgeting results indicated that a two-man, two-tractor machinery combination and 196 to 232 crop acres were required to achieve constant unit cost when custom operations were not considered.

Small machinery combinations had the lowest unit cost for small acreages (160 crop acres or less), but these costs were high relative to minimum unit cost. Total and average fixed costs for small machinery were less than large machinery combinations on small acreages. Small machinery combinations lacked the capacity to operate efficiently on large crop acreages, and as crop acreage increased, untimely field operations resulted in yield and revenue losses.

Custom operations can be used to reduce total and average fixed cost per dollar of crop product and to increase the capacity of small machinery combinations. To estimate the effect of custom operations on the relative efficiency of small and large machinery combinations, custom harvesting operations for the one-man, one-tractor machinery combinations were considered on the average farm. Custom operations increased the relative efficiency for the one-man, one-tractor machinery combinations and made these small machinery combinations as efficient on small acreages as were the larger machinery combinations on larger acreages. Minimum average total cost per dollar of crop product was achieved at 152 crop acres with custom operations. The budgeting results suggested that most of the cost economies available in crop production on the average farm could be achieved with: (1) A 1-man, 1-tractor combination and 152 to 288 acres of cropland; and (2) a 2-man, 2-tractor combination and 288 or more acres of cropland. However, cost reductions associated with custom operations would be overestimated if there were extensive waiting periods for custom operations.

Agr. and Home Econ. Expt. Sta., Iowa State U. Sci. and Tech., Ames, Iowa.

221. Tramel, T. E., and Long, J. T. POWER AND EQUIPMENT COSTS IN THE BROWN LOAM AREA OF MISSISSIPPI. Miss. Agr. Expt. Sta. B. 688, 14 pp. 1964.

As power and equipment are substituted for labor, the cost of these items form a larger part of farm expenses. Thus power and equipment costs are becoming more important considerations in planning the most profitable organization of Mississippi farms. The costs incurred by farmers in the Brown Loam Area of Mississippi in the operation of the major items of farm power and equipment were determined.

Tables.

Miss. Sate U., Agr. Expt. Sta., State College, Miss.

222. Puckett, H. B. AUTOMATIC FEEDING EQUIPMENT: FOR LIVESTOCK AND POULTRY. U.S. Dept. Agr. Farmers B. 2198, 28 pp. 1964.

Different types of automatic feeding equipment for livestock and poultry were described and illustrated.

ARS, USDA, Inform. Div., Room 645A, FCB, Hyattsville, Md., 20781

223. Kline, R. G. ECONOMIC ADJUSTMENTS FOR SMALL FLUE-CURED TOBACCO FARMS, SOUTH-SIDE VIRGINIA. Va. Agr. Expt. Sta. Tech. B. 174, 157 pp. 1964.

The southside Virginia economy is largely rural. It is composed of approximately 16,000 farms, of which only one-half had a gross income over \$2,500 in 1960. More than 95 percent of these farms have less than 150 acres of open land, and 80 percent have less than 50.

Analysis was made to find a combination of enterprises that would maximize returns to fixed resources (land, tobacco allotment, buildings, and operator and family labor) for two typical resource situations. Farms with 50 to 150 acres of open land were represented by a typical resource situation with 75 acres of open land; tobacco allotment, 5.7 acres; 1.64 man equivalents of operator and family labor; and \$23,042 available for added investments. Farms with less than 50 acres of open land were represented by a typical resource situation with 30 acres of open land; tobacco allotment, 3.1 acres; 1.14 man equivalents of operator and family labor; and \$11,170 for added investments. For each situation, it was assumed that seasonal labor could be hired at 90¢ per hour.

Optimum adjustments in general included either renting additional land and or utilizing some of the fixed labor for off-farm work. Hogs, layers, or contract broilers usually were included in optimum organizations on farms of both sizes. Steers also had a good potential on the larger farms.

The optimum adjustment for the larger farms, 75 acres open land, was to rent 73 acres of open land. An operator's labor income of \$5,480 could be obtained if annual rent of open land was \$35 per acre. Income was largely from the sale of 626 fat hogs and 17 steers, in addition to 5.7 acres of tobacco. A similar income could be obtained by renting slightly more land and renting out 5.7 acres of allotment, or by renting less open land and renting additional tobacco allotment. As more tobacco allotment was rented, fewer livestock were included in an optimum organization. Operator's labor income of \$5,234 was attainable on the larger farm if family labor was employed off the farm 45 hours per week, with net wages of 90¢ per hour for 40 hours per week. Twelve steers and 304 fat hogs, in addition to 5.7 acres of tobacco, were produced for sale.

Family labor working off the farm 45 hours per week was the best adjustment alternative for the small farm with 30 acres of open land. With wages of 90¢ per hour for 40 hours a week, operator's labor income of \$3,630 could be attained from the sale of 137 fat hogs, 370 bushels of wheat, and 8 tons of hay, in addition to 3.1 acres of tobacco and off-farm wages. Operator's labor income of \$3,470 could be attained by renting 23 acres of open land at \$35 per acre. In addition to the sale of 3.1 acres of tobacco, other sources of income were 256 fat hogs and 15 tons of hay.

When renting land and/or off-farm employment were not considered as alternatives, operator's labor income on the 75 acres of open land was not likely to exceed \$4,850. This income was attained by the sale of 455 fat hogs and 21 tons of hay, in addition to the 5.7 acres of tobacco. An income near \$4,800 could also be obtained with: (1) 419 fat hogs and 11 steers; (2) 80,300 contract broilers and 13 steers; or (3) 2,060 layers and 41 steers.

When renting land and/or off-farm employment were not considered for the small farm, operator's labor income was not likely to exceed \$3,340. This income was possible with 1,600 layers, the sale of 809 bushels of corn, 429 bushels of wheat, and 7

tons of hay, in addition to 3.1 acres of tobacco. An operator's labor income near \$3,300 could also be attained with the following combinations of enterprises in addition to 3.1 acres of tobacco: (1) 192 fat hogs, 410 bushels of sweet potatoes, and 7 tons of hay; and (2) 30,000 contract broilers, 670 bushels of corn, 354 bushels of wheat, 639 bushels of sweet potatoes, and 7 tons of hay.

Tables and graphs.

Va. Agr. Expt. Sta., Va. Polytech. Inst., Blacksburg, Va.

224. Tompkin, J. R., and Rafeld, F. J. ECONOMIC EVALUATION OF ACTUAL AND OPTIMAL ADJUSTMENTS IN RESOURCE USE ON 160-ACRE FARMS IN WEST CENTRAL OHIO, 1956-1959. Ohio Agr. Expt. Sta. Res. B. 965, 65 pp. 1964.

A cooperative study on farm adjustment in nine west central Ohio counties was conducted during 1956-59. Information for the 1956 crop year was obtained on 85 of 131 randomly drawn 160-acre owner-operated farms and data for 1957-59 were collected on a sub-sample of 37 farms. The following was obtained: An inventory of farm resources; a knowledge of how these resources were used; the adjustments the sample operators made to price and other stimuli; and to what extent profitable adjustments can and should be made on the sample farms and ultimately in the entire region.

The sample area lies in the Ohio portion of the midwestern corn belt.

Total farm adjustments were significantly influenced by: The amount of capital the operator had available; the amount of reinvestment in the farm business; and the amount of current cash costs incurred.

Crop adjustments depended more on the operator's debt position and the amount of cash costs per productive man work unit (PMWU).

Livestock adjustments varied with the capital position of the operator, the change in hog and corn prices over the previous year, and the age and education of the operator.

Labor and machinery adjustments generally followed the degree to which the operator was willing to reinvest disposable income into the farm business.

Technological adjustments were influenced primarily by: The capital position; a sustained rate of change in prices of livestock and livestock products; the level of current cash costs; and the reinvestment policy of the operator.

Cost adjustments were associated simply with the absolute level of current costs.

Improvements adjustments were related to: The operator's capital position; the willingness of the operator to reinvest in the farm business; and the cost of such major improvements ingredients as lime and fertilizer.

Capital use adjustments i.e., significant changes in either short term or long term debt-pattern—were highly correlated with current level of cash costs and with the amount of reinvestment the operator made.

The major characteristics associated with almost all types of adjustment were: (1) The general capital or risk bearing position of the operator, including his net worth and equity position; (2) the policy of the operator in reinvesting available funds; and (3) the cost level of the operator.

Shifts to increase fall or spring sow farrowings tended to follow the relative level of hog prices the preceding fall or spring, respectively.

Each sample farm was linear programmed with variable beef and hog prices. The number of changes in optimum plans, within a given range of product prices, for a given farm seemed to serve as a very good measure of the degree of resource flexibility on that farm, correlating positively and significantly with the amount of capital available and the size of the farm in terms of PMWU's.

The income difference between actual farm organization and programmed optimum resource allocation averaged \$2,458 per year for the 1957-59 period. These differences were associated significantly with: Increase in corn acreage; inclusion of more beef steers in the farm plan; feeding efficiency; cash cost efficiency; and general elimination or reduction of dairy enterprise on some farms.

Resource rigidity and a weak capital position were strong obstacles to adjustment. Voluntary resource rationing by the operator and his lack of knowledge of costs and returns of alternative enterprises also tended to deter adjustments.

Farms with strong capital positions and more animal units of livestock had higher total cash costs but lower cash costs per PMWU.

Tables, graphs, and maps.

Ohio Agr. Expt. Sta., Wooster, Ohio.

225. Martin, J. R., Lagrone, W. F., and Plaxico, J. S. EFFECT OF PRODUCT PRICES ON FARM ORGANIZATION AND INCOME—SANDYLAND FARMS—SOUTHWESTERN OKLAHOMA. Okla. Agr. Expt. Sta. B. B-625, 22 pp. 1964.

Information useful in appraising the effects of changes in price relationships on organization, production, and income on farms with sandy soils in southwestern Oklahoma was provided. A total of 30 various price relationships were analyzed, based on five price levels of cotton, three prices for grains and beef cattle, and two different charges for the use of capital.

With any combination of feed grain prices and capital charges, large acreages of cotton were included in the optimum combination of enterprises at a cotton price of 22 cents or more per pound of lint. Also, at a cotton price of 17.6 cents and a 6 percent interest cost on nonland capital, cotton production was important. Grain sorghum production was most important at low cotton prices, base or higher feed grain prices, and a 6 percent capital cost. Wheat production was greatest at low cotton prices, base or higher feed grain prices, and an 18 percent capital cost. In general, cattle production was important at base or higher prices. A wind erosion hazard required that a rye winter cover crop be planted on cotton land. The winter grazing provided by the cover crop resulted in a complimentary relationship between cotton and beef stocker cattle production. Consequently, beef stocker numbers increase with cotton acreage at base or higher cattle prices. With low prices for all products and an 18 percent charge for nonland capital, only 111 acres of the most productive cropland were used and 389 acres were idle. Labor requirements were greatest in organizations containing large cotton acreages and stocker cattle enterprises. Net returns ranged from a low of about \$2,100 at low prices for all products and an 18 percent capital charge to a high of more than \$21,000 with high prices for all products and a 6 percent interest charge. At base prices for feed grains and a capital cost of 6 percent on nonland capital, an organization with 355 acres of cotton was optimum or near optimum over a range of cotton prices from 18.1 to 30.8 cents per pound.

The results are "normative" estimates of what it would pay on the representative farm. They reflect the optimum organizations if the farm was operated in the efficient manner assumed, if the farmers had perfect knowledge of prices and costs, and were not limited by acreage allotments or production controls.

Tables.

Okla. State U. Expt. Sta., Stillwater, Okla.

226. Partenheimer, E. J., and Strickland, P. L., Jr. OPTIMUM FARM ORGANIZATION AND AGGREGATE AREA PRODUCTION, WIREGRASS AREA (LOWER COASTAL PLAINS), ALABAMA. Auburn U. Expt. Sta., Agr. Econ. Ser. 3, 95 pp. 1964.

Four representative farm sizes in the Wiregrass Area of Alabama were studied under assumed conditions of estimated free market prices, no production controls, and improved production technology. Budgets were prepared for each size of farm and linear programming procedures were used to select the optimum combination of enterprises. Three sets of programs were computed. The first set included selling Coastal bermudagrass hay and purchasing corn as alternatives; the second excluded selling hay; and the third excluded both selling hay and buying corn.

In all cases peanuts came into the optimum program at the maximum allowed by an agronomic restriction. Cotton was a strong competitor for resources, and the same was true of Coastal bermudagrass hay on the two larger size farms.

When Coastal was eliminated either arbitrarily or because of high custom harvesting costs, the plowable open land unsuitable for row crops was used for oats, and the nonplowable open land was either used for hay and pasture for cattle or left idle. Corn was usually purchased and more livestock entered the optimum program. When corn buying was eliminated, livestock numbers declined.

The effect of changing cotton prices was studied using the situation where both Coastal selling and corn buying were eliminated. Cotton prices were varied from 40 percent below to 40 percent above the 25-cent base price. With peanuts at base prices, all high-yield cotton entered the optimum plans at cotton prices between 17.8 and 21.3 cents per pound. Medium-yield cotton entered the plans in the following two groups: (1) That which replaced feed crops for steers and hogs; and (2) that which replaced peanuts. Medium-yield cotton replaced feed crops at cotton prices between 21.4 to 23.3 cents, and it replaced peanuts at prices between 31.0 and 32.0 cents per pound. Low-yield cotton replaced additional peanuts at prices between 35.0 and 37.1 cents per pound.

Cotton price was then held constant at base price and peanut prices were varied from 40 percent below to 40 percent above the \$160-per-ton base price. Peanuts replaced feed grains at peanut prices between \$100.32 and \$114.80 per ton. Part of the medium-yield cotton was replaced at peanut prices ranging from \$115.43 to \$125.46 per ton. Rotational restrictions on peanuts prevented further competition with cotton.

Agr. Expt. Sta., Auburn U., Auburn, Ala.

227. Rhodes, V. J. ECONOMIC CLASSES AND TYPES OF FARMS IN MISSOURI. Mo. Agr. Expt. Sta. B. 818, 19 pp. 1964.

The development of certain patterns among Missouri commercial farmers was reported.

The number of "\$10,000 plus" income farms more than doubled in Missouri from 1949-59. The "\$9,999 minus" farms fell almost half. By type of farm, the largest change in absolute number was the 25,500 decline in livestock farms. All types declined with the exception of cash-grain farming, which showed a 48 percent increase. By both groupings, the increase in "\$10,000 plus" farms was well spread over the six types of farming.

The sales of "\$10,000 plus" farms increased 141 percent. The sales of these farms increased for every type of farm except general farms.

Farm real estate values for the "\$10,000 plus" farms more than tripled in the decade. The "\$9,999 minus" farms remained constant in total value, even though the per farm figures doubled.

There is a pattern of "shifting types" of farms developing in Missouri. Younger farmers are shifting mostly into cash-grain farming from other types. The older farmers show a trend toward both cash-grain and livestock. On the basis of the "average number of farmers for the period", about 1 out of 11 farmers shifted in both the older and younger groups.

The other distinct pattern developing in Missouri agriculture is the increasing importance of crop production.

The relative importance of the commercial farm grossing \$10,000 or more in sales is on the increase in Missouri. The percentage value of all farm products sold by "\$10,000 plus" farms in Missouri changed from 33.7 percent in 1949 to 58.0 percent in 1959. The corresponding United States figures were 50.8 percent and 71.8 percent.

Tables, graphs, and maps.

U. Mo. Agr. Expt. Sta., Columbia, Mo.

228. Langham, W. J., and Coutu, A. J. AREA RESOURCE ADJUSTMENTS FOR SPECIFIED NET REVENUE GOALS AND LEVELS OF FACTOR PRICES ON FARMS IN ECONOMIC AREA 7, NORTH CAROLINA. N.C. State Dept. Agr. Econ. A. E. Inform. Series No. 109, 87 pp. 1964.

The nature and magnitude of resource adjustments in agriculture in Economic Area 7 that would be consistent with the achievement of farm and nonfarm income equality goals with present and projected factor and product prices were studied in a 9-county area in the northern part of the North Carolina Coastal Plain.

The farm organizations which would provide specified levels of net revenue with minimum amounts of land for currently predominant types of farms were determined by linear programming procedures. Nineteen types of farm situations, including 5 allotted crop farm types and 14 specialty product farm types, were programmed.

For the current situation, the assumed conditions were similar to those now prevailing in the area but included use of advanced production technology. Under these conditions, 26.5 acres of cropland and \$11,764 investment capital were required for the operator of an allotted crop type of farm to achieve a \$2,500 net revenue level with a minimum amount of land.

Cropland and investment requirements to attain a \$4,500 net revenue level with the minimum amount of land in the current situation were 76.5 acres and \$34,744 for the allotted crop type farm.

For the projected situation, type of farm organizations were programmed under assumptions of farm wage rates at 150 percent of present levels and lower product prices for all specialty products. To achieve a \$4,500 net revenue level, 91.1 acres of cropland and \$38,421 in total investments were required for the allotted crop type of farm.

In the \$6,500 net revenue level projected situation, the cropland requirement for the smallest size allotted crop type farm was 125.4 acres with a total investment requirement of \$55,802.

Two higher levels of land prices, current plus 40 percent and current plus 80 percent, were programmed for the allotted crop type farms in the projected situation. As land prices were raised to these higher levels, the cropland requirements usually increased about 15 to 25 acres per farm unit in order to maintain the same level of net revenue.

The net revenue restraint was limitational for all solutions. Allotted crop acreage ratios were more limiting for the lower net revenue level and lower land price situations. At the higher net revenue levels and at the higher land price situations, the farm size was larger and the fixed quantity of operator labor became a more important limiting factor. The gross return requirement from a particular activity or group of activities to meet the specified type of farm condition was limitational in nearly all instances.

A minimum adjustment gap for the area was estimated for each of the situations by recognizing the resources available on farms not currently at or above the specified net revenue levels. Such estimates provided information regarding the maximum number of farms, by type, that the area can support.

For all farm operators to achieve a minimum \$4,500 net revenue level for the current situation, the number of farms in the area would be decreased by 45 percent from present levels.

In the projected factor and product price situation, the area could support an estimated 6,800 farms with all operators of these reorganized farms receiving a minimum \$4,500 return to their labor and management. This is 52 percent fewer farms than were in the area in 1960. The increase in farm wage rates from 60 cents per hour in the current situation to 90 cents per hour in the projected situation results in the substitution of some land intensive enterprises for some of the labor intensive enterprises. All available peanut allotted acreage would be used but only small acreages of tobacco and cotton would be planted. Pork would be the only specialty type commodity produced. With the minimum net revenue level raised to \$6,500, the area's resources would be able to support an estimated 5,200 farms.

Tables, graphs, and maps.

N.C. State, U. N.C., Raleigh, N.C.

229. Goodsell, W. D., and Gray, J. R. COSTS AND RETURNS: WESTERN LIVESTOCK RANCHES, 1963. U.S. Dept. Agr., Econ. Res. Serv. FCR-18, 10 pp. 1964.
230. Shugars, O. K. COSTS AND RETURNS: COMMERCIAL TOBACCO FARMS COASTAL PLAIN, NORTH CAROLINA, 1963. U.S. Dept. Agr., Econ. Res. Serv. FCR-19, 9 pp. 1964.
231. Brown, W. H., Lee, J. E., Jr., and Hole, E. COSTS AND RETURNS: COMMERCIAL COTTON FARMS, 1963. U.S. Dept. Agr., Econ. Res. Serv. FCR-20, 13 pp. 1964.
232. Hurd, E. B. COSTS AND RETURNS: COMMERCIAL WHEAT FARMS, PACIFIC NORTHWEST, NORTHERN PLAINS, AND SOUTHERN PLAINS, 1963. U.S. Dept. Agr., Econ. Res. Serv. FCR-21, 12 pp. 1964.
233. Cummins, D. E. COSTS AND RETURNS: COMMERCIAL DAIRY FARMS NORTHEAST AND MIDWEST, 1963. U.S. Dept. Agr., Econ. Res. Serv. FCR-22, 9 pp. 1964.
234. Shugars, O. K., and Bondurant, J. H. COSTS AND RETURNS: COMMERCIAL TOBACCO-LIVESTOCK FARMS, BLUEGRASS AREA, KENTUCKY, 1963. U.S. Dept. Agr., Econ. Res. Serv. FCR-23, 9 pp. 1964.
235. Rosenberry, P. E. COSTS AND RETURNS: COMMERCIAL CORN BELT FARMS, 1963. U.S. Dept. Agr., Econ. Res. Serv. FCR-24, 5 pp. 1964.
236. Stoddard, E. O., II, and Carncross, J. W. COSTS AND RETURNS: COMMERCIAL EGG-PRODUCING FARMS NEW JERSEY, 1963. U.S. Dept. Agr., Econ. Res. Serv. FCR-25, 8 pp. 1964.
237. Stoddard, E. O., II. COSTS AND RETURNS: COMMERCIAL BROILER FARMS MAINE, DELMARVA AND GEORGIA, 1963. U.S. Dept. Agr., Econ. Res. Serv. FCR-26, 13 pp. 1964.

These nine publications give the costs and returns for the crop and areas listed for 1963.

Maps, tables, and graphs.

MOS, USDA, Inform. Div., Washington, D.C., 20250

238. Barr, A. L., Welsch, J. A., Rosenberger, J., and Wamsley, B. W., Jr. SHEEP PRODUCTION—COSTS AND RETURNS IN WEST VIRGINIA. W. Va. Agr. Expt. Sta. B. 495, 23 pp. 1964.

An analysis of data useful in evaluating factors that influence costs and returns for a sheep enterprise in West Virginia was reported. The basic data were obtained from Master Shepherd's Project reports and some estimates for the 5 year period, 1957-61. The study encompassed 305 records, or an average of 3,103 breeding ewes and 61 flocks per year. There was an average of 51 breeding ewes per farm flock.

There were 1.25 lambs averaging 86 pounds produced per breeding ewe. Thus, 108 pounds of lamb were produced per breeding ewe. The lambs were sold for an average of 20 cents per pound and returned an average of \$21.60 per breeding ewe for lambs. The average fleece weight produced per breeding ewe was 7 pounds, which sold for an average of 51 cents per pound--a return from the sale of wool of \$3.60 per breeding ewe. The estimated incentive payment of \$1.93 per ewe for wool and unshorn lambs added to the average wool sales of \$3.60 gave a total income from wool of \$5.53 per breeding ewe. Thus there was a total return of \$27.13 per breeding ewe. The estimated, specified costs per breeding ewe were \$16.05. The average return to labor, capital, and management per breeding ewe were \$11.09. The average return to labor, capital, and management per breeding ewe was \$18.70 for the highest income group and \$1.48 for the lowest income group.

Tables and maps.

W. Va. U. Agr. Expt. Sta., Morgantown, W. Va.

239. Bennett, J. A., Matthews, D. H., and Madsen, M. A. RANGE SHEEP BREEDING STUDIES IN SOUTHERN UTAH. Utah Agr. Expt. Sta. B. 442, 27 pp. 1963.

Lamb and wool production was studied for range Columbia, Targhee, and Rambouillet ewes under southern Utah conditions. Weaning records of 8,740 lambs over a 9-year period and 3,967 shearing records over 6 years were analyzed. The author concluded that:

1. Targhee ewes weaned 132.2 lambs for each 100 ewes bred, Rambouillets 124.2, and Columbias 113.8.
2. Calculated lamb value per ewe bred was \$15.51 for Targhee, \$14.38 for Rambouillet, and \$14.01 for Columbia.
3. Calculated wool returns per ewe were \$5.95 for Rambouillets, \$5.40 for Targhees, and \$5.29 for Columbias.
4. Calculated total returns per ewe for lamb and wool combined were \$20.91 for Targhees, \$20.33 for Rambouillets, and \$19.30 for Columbias.
5. Columbia lambs were 1.50 pounds heavier at weaning than Targhee and 3.36 pounds heavier than Rambouillet lambs.
6. Columbia lambs were slightly fatter, had slightly longer staple, and were more open faced than Targhee lambs.
7. Targhee lambs were fatter, longer in staple, and more open faced than the Rambouillet.
8. Age of dam had a strong influence upon birth and weaning weights, and condition of lambs at weaning.
9. Single lambs were heavier at birth and also were 13.6 pounds heavier and 2/3 of a grade fatter at weaning time than were twins.
10. Twins reared as singles were 5.92 pounds heavier at weaning than were twins reared as twins.
11. Male lambs were 0.52 pounds heavier at birth than females.
12. Wether lambs, at weaning, weighed 5.41 pounds more than ewe lambs.

13. Columbia ewes produced 0.30 pounds more clean wool than Rambouillets and 0.27 pounds more than Targhees. The Columbia staple was 0.57 inches longer and 1.45 grades coarser than the Rambouillet. Targhee wool was only 0.04 inches shorter and 0.38 of a grade finer than Columbia.
14. Age of ewe influenced wool production. Two-year-old ewes produced the heaviest fleece with the longest staple.
15. Larger ewes produced more wool per ewe, but smaller ewes produced more wool per unit body weight.

Tables and photographs.

Agr. Expt. Sta., Utah State U., Logan, Utah.

240. Animal Husbandry Research Division. FINISHING BEEF CATTLE. U.S. Dept. Agr. Farmers B. 2196, 30 pp. 1964.

A complete guide for finishing beef cattle was given for the farmer.

ARS, USDA, Inform. Div., Room 645A, FCB, Hyattsville, Md., 20781

241. Nelson, A. B., Pope, L. S., and Stephens, D. F. EFFECTS OF STILBESTROL ON RANGE BEEF CALVES AND YEARLINGS. Okla. Agr. Expt. Sta. B. 620, 18 pp. 1964.

Stilbestrol implants of 12 to 15 mg. in 3 to 4 month old suckling steer calves increased weaning weights about 22 lb. in 20 comparisons. With heifers the response, although greater on the average, resulted in more adverse side effects such as swollen vulva and increased teat length. The implantation of steers at the above level had no detrimental effect on feeder grade; in fact, they appeared to be fatter and showed more "bloom" in most trials. Higher implant levels resulted in more adverse side effects and high tail heads; lower implant levels (6 mg.) gave less grain response. Implanting appeared to give a greater gain response than feeding stilbestrol in the creep-mix. Response to stilbestrol implants was greater with spring than fall-dropped calves.

Grains of yearling steers grazing good native pastures were increased about 15 percent by implanting with stilbestrol. From the levels used during the summer grazing phase it appears that 12 mg. was most satisfactory.

Winter gains on dry grass or in a trap on hay were slightly improved by implanting with 12 mg. Increased gains made by summer-implanted suckling calves were not lost during the following winter.

Feedlot performance of calves which had been previously implanted was not adversely affected. With yearlings, average daily gains on feed were slightly reduced, and in some cases previous summer gains were nullified.

Results indicate that: (1) The implant level should be kept low to avoid adverse side effects, yet get a good gain response; (2) young suckling heifers should not be implanted because of adverse side effects and possible appearance of heat or estrus; (3) the commission man or feeder buyer should be advised of the use, level, and time of stilbestrol implant; and (4) only one implant should be made, preferably 120 days or so before marketing and while cattle are on the best grass, or when steer calves are 3 to 4 months of age.

Okla. State U. Expt. Sta., Stillwater, Okla.

242. Petit, J. A., Jr., and Dean, G. W. ECONOMICS OF FARM FEEDLOTS—IN THE RICE AREA OF THE SACRAMENTO VALLEY. Calif. Agr. Expt. Sta. B. 800, 43 pp. 1964.

An actual farming operation of about 1,000 acres was used to define the basic physical resources and the production possibilities for farm feedlots in the rice area of the Sacramento Valley in California. Linear programming was used to determine the most profitable crop and livestock programs and the income levels possible for this farm. Plans were developed: (1) For a cash crop operations; (2) for operations including a farm feedlot of 1,500-head capacity, silos and silage handling equipment, and a choice of six rations using silage; and (3) for operations including the same 1,500 head feedlot, a feed mill and associated equipment, and a choice of four rations, including an all-concentrate ration (barley + supplement) and three other conventional grain-hay rations. The main findings of the study were:

1. The cash crop farm alone (emphasizing rice production) provided an annual management income of about \$10,000.
2. Addition of the various types of cattle feeding programs increased potential management income to \$40,000 to \$80,000 per year.
3. The most profitable nonsilage ration was all-concentrate (barley + supplement); the most profitable silage ration included alfalfa haylage, oats-vetch haylage, and barley.
4. It was always more profitable to raise the maximum acreage of rice permitted by government allotments, and buy part of the grain fed.
5. Incomes from the optimum plans including cattle feeding were very sensitive both to the level and the margin of cattle prices.
6. If the optimum programs presented had been followed over the past 11 years, potential incomes would have been variable (ranging from about \$50,000 to \$200,000 annually) but in no case as low as from cash crop farming alone.
7. The level of profits and the choice of the optimum rations also were quite sensitive to the daily gains specified.

These conclusions were based on near-peak efficiency as to crop yields, production costs, cattle feeding efficiency, death losses, and general operation of the farm business. For operators with sufficient capital and the managerial capacity to make the major shift from cash crops to a crop-livestock program, cattle feeding appeared to be an alternative worthy of careful consideration in many parts of the rice area.

Tables and graphs.

Calif. Agr. Expt. Sta., U. Calif., Davis, Calif.

243. Anderson, R. H. THE TURKEY INDUSTRY: AN ECONOMIC APPRAISAL. Utah Agr. Expt. Sta. B. 445, 19 pp. 1964.

Some of the factors concerning Utah's competitive position in the turkey industry were studied to: (1) Determine recent and long-time costs and returns in turkey production in Utah; (2) indicate the present importance of the industry and the conditions for its future development in the state; and (3) analyze factors associated with costs and returns from turkey production on individual farms.

Data on costs and returns were obtained for about 40 turkey producers in Sanpete and Sevier Counties for 1961 and 1962. Similar data were obtained from 14 producers in Box Elder, Davis, and Weber Counties for 1962. The author concluded that:

1. Utah has maintained a rank among states of sixth to eighth in a rapidly growing industry in spite of the need to import feed, the most important cost item.
2. In 1960, the turkey industry provided in excess of 10 million dollars to the input factors which originated in Utah. Turkey processing and farm production each accounted for about 4 million dollars, feed mixing and handling about 1.5 million, and poult breeding and hatching a half million dollars.
3. Average net return from turkey production in Utah was extremely favorable from 1941-48 reaching in some years as much as nine cents per pound of turkey. Since 1949, losses and profits have alternated rather regularly in a 2-year cycle and net return for the entire period has been near zero.
4. Based on 36 flocks in Sanpete County in 1961, cost of turkey production was about 25 cents per pound eviscerated. Feed amounted to nearly two-thirds of total cost, poult 16 percent, labor 6 percent, and other costs 12 percent. In physical terms, 4.5 pounds of feed were required per pound of eviscerated turkey and 1.24 hours of labor per 100 pounds of eviscerated turkey produced. Average death loss was 12 percent.
5. Feed conversion, death loss, and labor efficiency were related to net return. These three factors were interrelated and when considered together by multiple correlation, they accounted for 51 percent of the variation in net return.
6. Flocks of 7,500 birds showed slightly greater net return than those of three to five thousand. The major reason was increased labor efficiency.
7. Low year-to-year correlation between 1961-62 feed conversion and death loss for flocks of 22 operators indicated little control over these factors through management.
8. Because of an economic disadvantage in transfer costs of both feed and finished product aggregating 3 to 4 cents per pound of turkey, Utah is not likely to increase her relative position among states in turkey production. Experienced producers with physical facilities and satisfactory tie-in arrangements for raw materials and turkey processing will continue in turkey production. On the average, net return will be slim and will accrue only to better-than-average managers.

Tables and graphs.

Agr. Expt. Sta., Utah State U., Logan, Utah.

244. Martin, J. A., and Hicks, B. G. THE ECONOMICS OF USING LOW-QUALITY HARDWOODS FOR PRODUCING CHARCOAL IN TENNESSEE. Tenn. Agr. Expt. Sta. B. 375, 38 pp. 1964.

The removal of cull hardwoods is one of the principal production and management problems in Tennessee forest economy. While some cull hardwoods are used as fuel, pulpwood, fence posts, and cross ties, their annual growth rate exceeds their rate of use. The charcoal industry offers a chance to improve quality of trees growing in the state's forests, and higher forest income, as well as increase employment by converting the cull hardwoods to charcoal. The author concluded that:

1. If the present trend toward increased outdoor cookery should continue, the charcoal briquette industry could be a ready market at a paying price for cull hardwoods.
2. At wages of \$1.25 per hour, a cord of charcoal type wood can be cut and hauled 20 miles at a cost of \$12.52. This cost diminished to \$10.66 for a farmer cutting his own wood during the off season.
3. There were very definite cost advantages in large scale production of charcoal. The small scale plant could not pay \$1.25 per hour for labor and

- still pay enough for wood to cover harvesting cost.
4. Increased plant volume would decrease costs of producing charcoal, including the popular charcoal briquettes. Up to \$22.53 could be paid for wood for producing a ton of briquettes, which could be produced for \$85.83 per ton with a kiln of 1 ton per hour capacity.
 5. Larger capacity and more expensive charcoal-processing machinery of both foreign and domestic manufacture is available for producing charcoal at a rate of 2 tons per hour. With such machinery, wages of \$1.25 and \$1.00 per hour could be paid plant and wood harvesting employees and still buy stumpage for about \$2.00 per cord.

U. Tenn. Agr. Expt. Sta., Knoxville, Tenn.

Institutional, Educational, and Social Factors Affecting Conservation Application

SEE ALSO 244.

245. Pavlick, A. L. TOWARDS SOLVING THE LOW-INCOME PROBLEM OF SMALL FARMERS IN THE APPALACHIAN AREA. W. Va. Agr. Expt. Sta. B. 499T, 71 pp. 1964.

Income estimates for the year 1956-58 suggest that Appalachian farmers earn less on the average than other U.S. farmers. Average income of typically Appalanian West Virginia farmers was less than that of U.S. commercial farmers and all farmers by more than \$500 in 2 of the years under study and by more than \$1,000 in the third year. Estimates of living levels of Appalachian farmers indicate that Appalachian farmers live at lower levels than other U.S. farmers. Almost two-thirds of the Appalachian counties fell into the lowest one-fifth of all U.S. counties and most of the remaining fell into the next lowest one-fifth.

Analysis of the effects of federal programs on Appalachian farm income indicates that they are positive but small. Only one-third or less of the Appalachian farms participated directly in the Price Support, the Soil Bank, and the Conservation Program in 1957-58. Direct payment per Appalachian farmer amounted to less than \$45.00. Indirect effects were estimated to average not more than \$120 annually per Appalachian farmer for the years 1954-58.

Analysis of land resources in West Virginia and human resources on small West Virginia farms suggests that there is little prospect for small Appalachian farmers to achieve satisfactory incomes from farming because small farms cannot be enlarged to commercial size.

Because opportunities for significant income improvement in agriculture are extremely limited for small Appalachian farmers, the following nonfarm programs were suggested: (1) A forest improvement program; (2) a retraining and outmigration program; (3) increased welfare to the needy; and (4) an improved educational system for school-age youth. Crude cost-benefits estimates for forest improvement in West Virginia suggest that such projects could: (1) Provide employment for all underemployed able-bodied farm operators in the project area up to their retirement; (2) provide some supplementary income to most retired and disabled operators through proceeds from the sale of land; (3) take land permanently out of agriculture; and (4) perhaps yield a positive return on the total project investment.

Job retraining programs for unemployed adults should include job placement wherever possible, particularly when employment opportunities are outside the area. Since young people will need to migrate to find employment for some time to come, the quality of public education in the Appalachian region should be improved to at least meet national norms. This will require federal aid. General education and nonfarm vocational training should be emphasized, and training in vocational agriculture in most areas should be reoriented in the direction of greatest employment potential.

Maps, tables, and graphs.

W. Va. U. Agr. Expt. Sta., Morgantown, W. Va.

246. Skok, R. A., and Lindmark, R. D. EFFECTIVENESS OF THE MINNESOTA TREE GROWTH TAX LAW. J. Forestry 62(10): 724-728. 1964.

Changes in per acre taxes levied against forest lands resulting from use of the recently adopted Tree Growth Tax Law were studied in four northern Minnesota counties. A description of the law sufficient to provide an understanding of its method of application and its differences from the ad valorem system was given. Lands entered under this law have received a significant reduction in tax per acre on the average. Features of this law were examined to indicate their economic consequences for the local taxing units and for owners with land under the law.

School Forestry, U. Minn., St. Paul, Minn.

247. Soil Conservation Service. RECREATION IN SMALL WATERSHED PROJECTS: A PROGRAM FOR RURAL AREAS DEVELOPMENT. U.S. Dept. Agr. PA 610, (Irr. pp.) 1964.

An illustrated and descriptive guide was given of recreation opportunities in small lakes created on small watershed projects.

Even the single-purpose reservoirs—those engineered solely for flood prevention—offer some recreation development possibilities.

The watershed reservoirs will have more lasting benefits, however, if planned for public recreation and for fish and wildlife development in the beginning.

The U.S. Department of Agriculture may now help local project sponsors enlarge dams to form bigger and deeper bodies of water that are better suited to a full range of water-based fun. USDA can also help local sponsors pay for land rights and build recreation facilities bordering the water.

Minimum basic facilities may include boat docks and ramps, beach development, picnic tables and fireplaces, sanitary facilities, public water supply, power facilities, roads and trails, parking lots, and other similar or related facilities needed for public health, safety, access to, and use of the recreation area.

Federal cost sharing for land rights includes the land in the reservoir needed for recreation purposes and the adjacent land area set aside for recreation and for access roads.

Local sponsoring organizations must pay their share of the recreation development costs and in addition assume the responsibility for operating and maintaining the watershed structure and recreation area.

SCS, USDA, Inform. Div., Washington, D.C., 20250

248. Keith, L. B. SOME SOCIAL AND ECONOMIC VALUES OF THE RECREATIONAL USE OF HORICON MARSH, WISCONSIN. Wis. Agr. Expt. Sta. Res. B. 246, 16 pp. 1964.

The number of goose watchers and goose hunters attracted to Horicon Marsh, Wis., was determined and how much they, and others, spent locally for such outdoor recreation was estimated.

Approximately 41,500 persons in 1960, and 75,800 in 1961, came expressly to watch the geese at Horicon Marsh during the fall. Most goose watchers seemed to have little other contact with wildlife. All occupational groups were represented in roughly the same proportion as in the population.

There were about 40,500 goose-hunter trips to Horicon Marsh in 1960, and about 44,500 in 1961. Private lands accommodated 88 percent of the hunters.

Farmers around Horicon Marsh took in an estimated \$63,855 in 1960, and \$59,450 in 1961, from the sale of goose-hunting privileges.

Merchants in communities near Horicon Marsh gained at least \$500,000 in sales annually from Marsh-associated recreation.

Agr. Expt. Sta., U. Wis., Madison, Wis.

BIOLOGY

Fish

SEE ALSO 2, 106.

249. Byrd, I. B., and Swingle, H. S. POND FERTILIZATION COST CAN BE REDUCED BY 66 PER CENT. Ala. Conserv. April-May, 4-6. 1964.

Recent experiments by fisheries research biologists in Alabama have demonstrated that the cost of fertilization can be reduced approximately 66 percent in most old ponds where fertilization has been practiced during the preceding 3 to 5 years and where pond weeds have been eliminated.

Ponds in many watersheds get sufficient potassium from pastures and croplands. Even in potassium-deficient soils, after a few years of fertilization with a complete fertilizer containing nitrogen, phosphorus, and potassium, the bottom muds of a pond accumulate sufficient potassium so that this element is no longer needed in the fertilizer.

After a few years of pond fertilization, the bottom muds also accumulate a rich store of organic matter from decomposing microscopic plants. Certain kinds of bacteria are able to take the atmospheric nitrogen dissolved in pond water and transform it into a form which can later be released into the water as ammonia from the bottom muds. This ammonia, while providing a source of nitrogen together with that resulting from decomposition of dead plants and animals, is used to grow new crops of microscopic plants in ever-recurring cycles. Thus, nitrogen can be eliminated from the pond fertilizer after a complete fertilizer had been used long enough to bring all underwater weeds under control and the bottom muds had accumulated the necessary organic matter. The phosphate that accumulates in the bottom muds, is changed into insoluble forms so that it is no longer available as a fertilizer. Consequently fertilization with phosphate must be continued each year. Fertilization with phosphate only will cost approximately one-third as much as the use of a complete fertilizer such as 8-8-2 or 20-20-5. The average yearly cost of fertilizing with phosphate only was about \$6.00 per surface acre of water. At each application, 40 pounds of superphosphate or 18 pounds of triple superphosphate should be applied.

Where possible, the first application of phosphate should be made about February 1 of each year, followed by two more applications at 2 week intervals. Additional applications should be made at 3 to 4 week intervals until November.

Whenever the water appears sufficiently murky with microscopic plants so that an object can not be seen deeper than 12 inches underwater, the next application may be postponed to a later date or omitted if the pond water maintains a dark green color. Most old ponds in Alabama will normally require from 10 to 12 applications of phosphate each year.

Chief, Fisheries Sect., Ala. Game and Fish.

250. Parker, W. D. "WILD FISH" CAN UPSET BALANCE IN FARM PONDS. Ala. Conserv. 34(4): 11-13. 1964.

For the past several years, farm ponds have been built at a rate of about 1,000 per year in Alabama. These farm ponds provide fishing for about half of the 750,000 fishermen in the state.

Of major importance in a pond management program is the proper stocking of the pond. A pond owner must use the correct numbers and kinds of fish. The best results are obtained when ponds are stocked with 100 largemouth bass and 1,000 bream (bluegills and shellcrackers) per acre. These three species of fish are produced at the State Fish Hatcheries and are furnished free upon application for the stocking of new ponds and lakes in Alabama that are one fourth acre or more in surface area and free of fish.

Unbalanced fish populations account for the majority of pond management problems. One of the more common factors for unbalanced fish populations is the presence of "wild fish" in the pond.

There is no method known which will guarantee the pond owner absolute immunity to "wild fish" infestations. The best insurance a pond owner can have is a thorough job of watershed renovation and an effective fish barrier such as a four foot vertical drop in the spillway to prevent fish from entering the pond through the spillway during times of overflow. In addition, no fish should be added to the pond without the recommendation of a fishery biologist.

Watershed renovation requires the use of Cube or Derris power containing 5 percent rotenone. This work should be done during late September or October after the water has cooled enough to eliminate the possibility of spawning by any fish which may have escaped the treatment. The drain valve should not be opened following treatment since this may allow "wild fish" to migrate into the pond through the open drain pipe. A period of 2 to 3 weeks will usually be required for the treated water to become detoxified and safe for stocking hatchery fish.

Fishery Biol.

251. Nail, M. L. THE CATFISH...A FAMOUS NAME AMONG ALABAMA'S MANY NOTED SPORT FISHES. Ala. Conserv. 34(4): 6-10. 1964.

All members of the catfish family found in Alabama waters are similar in appearance and habits, yet there are differences in the individual species. Normally the catfish are classified into three groups.

The catfish group include the channel catfish (Ictalurus punctatus), the blue catfish (Ictalurus furcatus), the white catfish (Ictalurus catus), and the flathead catfish (Pylodictus olivaris). The members of this group grow to much larger sizes than those of the other groups. The channel catfish has become quite popular with many pond owners. Fair success has been obtained by stocking these fish at the rate of 500 channel catfish and 100 bass per acre then following a good fertilization program. Greater yields can be obtained from ponds by stocking with 2,000 or even 3,000 channel catfish and 100 bass per acre and following a good conscientious feeding program.

The members that comprise the bulkhead group are the yellow bullhead (Ictalurus notalis), the brown bullhead (Ictalurus nebulosus), the black bullhead (Ictalurus melas), and the flat bullhead (Ictalurus platycephalus). The members of this group are moderate in size with very few reaching a weight of 4-1/2 pounds.

Members of the madtom group that are found in Alabama are Noturus gyrinus, Noturus leptacanthus, Noturus frenebris, Noturus insignis, and Noturus miurus. These are by far the smallest members of the catfish family. Rarely do they exceed 6-8 inches in length. Most of the time, these fish will be 3-4 inches long.

The various types of catfish were described. A brief description of their food habits and management practices were given.

Dist. Fishery Biol.

252. Shell, E. W. CONTROL OF AQUATIC WEEDS WITH FISH. Ala. Highlights Agr. Res. 11(2): 16. 1964.

To combat weeds in ponds, the owner has a choice of using chemicals (herbicides), cutting mechanically, controlling by fertilization, or combining these methods. However, there are disadvantages associated with any one of them.

In recent years, use of herbivorous fish (pond weed eaters) has been added as another control method. As a result of converting weeds into fish flesh, total production is higher than of fish that feed on water animal life. The effectiveness may last longer than other control methods and problems resulting from use of toxic compounds are not encountered.

The Israeli strain of the common mirrow carp and three species of tropical tilapia were tested.

All species of fish tested were effective in eliminating aquatic weeds from ponds containing only those species. However, when stocked in ponds containing established populations of largemouth bass and bluegills at rates that did not interfere with population balance, the effectiveness of the herbivorous fish was somewhat reduced.

The Israeli carp was effective in controlling several types of submerged and emergent aquatic weeds and filamentous algae when stocked at a rate of 25 to 50 fish per acre in ponds containing large mouth bass and bluegills. However, the stocked carp must be at least 7 in. in length. Smaller fish are easy prey for bass in the pond.

Of the three tilapia species tested, the Congo was the most promising. Stocked at a rate of 1,000 to 2,000 fish per acre, this species controlled filamentous algae and several rooted aquatic weeds. The Nile tilapia stocked at the same per acre rate was effective in controlling the algae but not the rooted aquatic weeds. The Java tilapia was not a promising species for control of either algae or rooted weeds. For best results both the Congo and Nile tilapias must be stocked by early May.

Neither the Nile nor Congo tilapias can withstand minimum winter temperatures in Alabama ponds. Procedures must be devised for holding these fish in springs, artesian well overflows, or water warmed by other means. Water temperature must not go below 50° F. if these fish are to survive. Israeli carp reach a size of 25 to 30 lb. after 3 or 4 years in ponds. The tilapia grow faster and to larger size than bluegill. Tilapia are easy to catch on hook and line.

Agr. Expt. Sta., Auburn, U., Auburn, Ala.

Upland Wildlife

SEE ALSO 2, 99, 164, 172, 248.

253. Severinghaus, C. W., and Tanck, J. E. PRODUCTIVITY AND GROWTH OF WHITE-TAILED DEER FROM THE ADIRONDACK REGION OF NEW YORK. N.Y. Fish and Game J. 11(1): 13-27. 1964.

To test the possibility that inherent characteristics are responsible for the low weights and reproductive rates of deer in the central Adirondacks, typical fawns (eight male and eight female) were transferred from an area where substantial winter starvation was chronic to corrals on an area in the southern part of the State having a less severe climate and an adequate food supply. During five winters, the average population was equivalent to 36 to 38 deer per square mile in one corral and 62 to 64 deer per square mile in the other. At these densities, the available food supply was fully utilized. The reproductive rates of the transferred stock, as adults, were equal to the best in New York. Their progeny averaged significantly heavier than deer from the central Adirondacks at comparable ages.

N. Y. State Conserv. Dept.

254. Arnold, D. A., and Verme, L. J. TEN YEAR'S OBSERVATION OF AN ENCLOSED DEER HEAR IN NORTHERN MICHIGAN. 28th North Amer. Wildlife and Natl. Resources Conf. Trans.: 422-430. 1963.

This study determined: (1) The population dynamics of a captive herd of white-tailed deer (Odocoileus virginianus) under comparatively natural conditions; (2) the ideal or maximum possible rate of exploitation; and (3) the ecological coaction between deer and the range in northern Michigan.

The enclosure is located at the Cusino Wildlife Experiment Station near Shingleton, Mich. The enclosed area is 647 acres. Altogether, the northern hardwood type comprised approximately 68 percent, swamp conifer type 9 percent, and open plains and semi-wooded area 23 percent of the area enclosed. A permanent stream flows through the area from west to east.

When the study began, 256 permanent plots were systematically laid out to help analyze the vegetation and to check on changes caused by plant succession and deer browsing.

The author concluded that the population dynamics of the enclosure herd were such that on the average, the annual increase constituted 32.8 percent (nearly a third) of the fall population. In early years when the range was in good condition, production was higher and a higher percentage of the herd could be removed. Accidents, predation, and other unforeseen losses accounted for removal of about 12 percent of the fall herd. In order to maintain the herd, a harvest goal approximating 20 percent permitted a buffer against unforeseen losses.

The natural succession of the forest affected the carrying capacity of the enclosure almost as much as did pressure by the deer herd. Future range management in the enclosure will move the plant succession back to a stage that is productive of deer.

Mich. Dept. Conserv., Shingleton, Mich.

255. Verme, L. J. EFFECT OF NUTRITION ON GROWTH OF WHITE-TAILED DEER FAWNS. 28th North Amer. Wildlife and Natl. Resources Conf. Trans.: 431-443. 1963.

Experimental feeding trials were conducted on penned, pregnant does in winter and spring to determine the effect of various dietary planes on pre- and postnatal development of white-tailed fawns. Malnutrition in the mother resulted in retarded length and weight growth of her fetus beginning at about 133 days gestation. At birth, fawns from nearly starved mothers averaged about 46 percent lighter, and they tended to be stunted skeletally, compared to young from well-fed does.

Early postnatal growth rate in fawns was inversely related to the does' earlier nutritional status. In contrast to malnourished deer, properly-fed mothers incur a proportionately greater lactation burden because they have bigger young, suckle more twins, and successfully rear their early-born offspring. Initially tiny fawns experience a faster, or compensatory, rate of growth compared to very large young. Hence, despite the original disparity in weights, the size gap may be practically non-existent at 4 weeks old. Fawns grow very rapidly and most of them roughly tripled in weight in the first month.

Mich. Dept. Conserv., Shingleton, Mich.

256. Suetsugu, H. T., and Menzel, K. E. WILD TURKEY INTRODUCTIONS IN NEBRASKA. 28th North Amer. Wildlife and Natl. Resources Conf. Trans.: 297-307. 1963.

Recent introductions of wild turkeys in Nebraska commenced with 28 wild-trapped Merriam's released in early 1959, and 518 Rio Grande turkeys released in 1961-62.

The 28 Merriam's increased to 125 the first production year, more than 300 the second year, about 1,000 birds the third, and a minimum of 3,000 birds in the fourth. Distribution and range extension increased from a 5-mile radius from the point of release the first year to 18 miles west of the site the second year. The third year, range extension was completed throughout the Pine Ridge area by natural dispersal and also by transplant into the northeastern part of the Ridge. Production was high.

Trapping and transplanting operations commenced in early 1961, and during 2 years 94 birds were transplanted to other sites in the state. Fair to good production has been realized at these release sites.

The first open season on Merriam's turkeys, confined to the Pine Ridge, was held in 1962. Of 500 permittees, 281 were successful in bagging turkeys.

Rio Grande turkeys were released at 25 sites, principally in the central and south-central portions of the state. Broods were observed at 18 sites, but population build-up has been considerably slower than in the Merriam's turkey. Several more years will be required before the results of Rio Grande introductions can be determined.

Game, Forestation, and Parks Comm., Lincoln, Nebr.

257. Dehlgren, R. B. RYTHMIC FLUCTIONS IN SOUTH DAKOTA PHEASANT POPULATIONS AND ASSOCIATED ADULT MORTALITY, 1947-62. 28th North Amer. Wildlife and Natl. Resources Conf. Trans.: 284-297. 1963.

Calculation of pre-hunt indices for the period 1947-62 has shown rhythmic trends with a "low" year every 3 years, followed by 2 "better" years. Data from states of North Dakota, Nebraska, Minnesota, and Iowa have shown similar patterns. States to the east of these appear to follow a different pattern of population trend. If the future follows the relatively precise regularity of the past 16 years, the western portion of the Midwest pheasant range may expect good pheasant years in 1963 and 1964 and a poor year in 1965.

Inconsistencies in bag-check age ratios, which implied high cock mortality in low years, prompted analyses of annually varying adult mortality. High adult mortality was found to occur during low years, and cock loss was found to be closely correlated with hen loss. The highest annual survival generally occurred in the year following the low. An assessment of the seasonal mortality pattern from fall to fall showed the bulk of mortality occurring from spring to summer, the next most influential period for mortality from August 1 to the hunt, and the least important period for mortality from fall to spring. An inverse relationship was demonstrated between over-winter mortality and spring-to-summer mortality.

S. Dak. Dept. Game, Fish, and Parks, Huron, S. Dak.

258. Pillmore, R. E., and Finley, R. B., Jr. RESIDUES IN GAME ANIMALS RESULTING FROM FOREST AND RANGE INSECTICIDE APPLICATIONS. 28th North Amer. Wildlife and Natl. Resources Conf. Trans.: 409-422. 1963.

A review of the literature and a discussion of the effects of residue on game animals from forest and range insecticide applications were given. The authors concluded that:

1. Sampling of tissues of game animals from forests treated with DDT for control of spruce budworm revealed the presence of DDT and derived residues in the fat ranging from 0 to 42 p.p.m. Other tissues contained lesser amounts of residues.
2. Lower residues of dieldrin (from 0 to 3.3 p.p.m.) were found in some fat samples of game animals from rangelands treated with aldrin or dieldrin for grasshopper control.
3. Wide variations in concentrations and total amounts of residue in deer and elk are caused by many factors, including spray area patterns, condition of vegetation, movements and behavior of game species, and physiological condition of animal.
4. The significance of these residues and their rates of elimination are not yet known.

Denver Wildlife Res. Cent., Br. Wildlife Res., Bur. Sport Fisheries & Wildlife, Denver, Colo.

Wetland Wildlife

SEE ALSO 2.

259. Linduska, J. P., and Nelson, A. L., Eds. WATERFOWL TOMORROW. U.S. Dept. Int. 770 pp. \$4.00. 1964.

Waterfowl Tomorrow is a book about the needs of the 48 species of ducks, geese, and swans that live on the North American Continent. Particularly, it is a book about the lands and waters that sustain these wildfowl in Canada, United States, and Mexico.

The 69 papers that were included were written by 103 authors selected from all sections of the United States and Canada. The papers were classified under the following headings: (1) Introduction; (2) The World of Waterfowl; (3) Duck Factories—The Big Three; (4) More Duck Factories; (5) Goose and Swan Factories; (6) Down the Flyways; (7) Nature at Work; (8) Men at Work; (9) Places to Hide - and Seek; (10) A Helping Hand; and (11) Waterfowl Tomorrow.

For sale by Supt. Doc., U.S. Govt. Print. Off., Washington, D.C., 20401

260. Nelson, H. K. RESTORATION OF CANADA GOOSE FLOCKS IN THE NORTH CENTRAL STATES. 28th North Amer. Wildlife and Natl. Resources Conf. Trans.: 133-150. 1963.

Captive flocks of Canada geese have been maintained on many national wildlife refuges and state waterfowl management areas throughout the northern tier of States since the areas were first established. Various sized groups have been introduced to serve as decoy flocks to attract migrant geese, to increase use of traditional wintering areas, and to re-establish breeding populations of Canada geese within portions of the original breeding range from which they have been absent since the early 1900's.

Introductions of local breeding flocks have met with varying degrees of success, depending upon source of breeding stock, breeding behavior, availability of suitable nesting sites, and losses from predation, natural mortality, and hunting mortality.

In the future, first priority will be given to use of goslings or mated pairs from established local breeding flocks; second priority will be given to use of carefully selected semidomestic stock.

Management techniques, research needs, and recommendations for continuation of the program were presented. Special attention was given to subspecific differences and adaptability of certain strains of breeding stock judged to be most suitable for use in establishing breeding populations in the North Central States.

The production by resident Canada goose flocks on 13 national wildlife refuges in the North Central Region during the period 1936-62 has totaled 22,300 with annual production averaging 1,500-2,000 birds the past 5 years. Production on the major state projects cited reached 2,600 in 1962. Collectively, state and federal areas in the North Central States are now producing 4,000-4,500 geese annually.

Bur. Sport Fisheries and Wildlife, Dept. Int., Minneapolis, Minn.

261. Hotchkiss, N. PONDWEEDS AND PONDWEEDLIKE PLANTS OF EASTERN NORTH AMERICA. U.S. Dept. Int., Fish and Wildlife Serv., Bur. Sport Fisheries and Wildlife C. 187, 30 pp. \$0.25. 1964.

This is the first of a series of publications on the field identification of the marsh and water plants of eastern North America. Twenty-seven pondweeds and thirteen non-pondweeds were described and illustrated.

For sale by Supt. Doc., U.S. Govt. Print. Off., Washington, D.C., 20401

262. Butler, P. A., and Springer, P. F. PESTICIDES—A NEW FACTOR IN COASTAL ENVIRONMENTS. 28th North Amer. Wildlife and Natl. Resources Conf. Trans.: 378-390. 1963.

Pesticides are used so widely now that they must be reckoned a significant factor in the environments of fish and wildlife. Increasing attention is being devoted to study of their effects on important coastal resources. Chemicals may be directly toxic or exert an indirect influence through reduction of food-chain organisms or modification of the habitat. Another mode of action is biological concentration in successive food-chain organisms. Information was summarized on the known effects of pesticides on coastal life from plankton to mammals. Toxicity varied greatly among different organisms and chemicals. Some marine forms appeared to be unaffected by recommended or registered pesticidal applications while others were susceptible to poisoning at concentrations of a fraction of a part per billion. Use of less persistent chemicals that are more specific for individual pests and less toxic to non-target organisms offers promise for the future, particularly when integrated with physical and biological methods of control.

Bur. Com. Fisheries Biol. Lab., Gulf Breeze, Fla.

SUPPLEMENT

Problems Indirectly Affecting the Application of Soil and Water Conservation Practices

SEE ALSO 26, 32, 66, 67, 68, 111, 126, 154, 183, 184, 192, 203, 204, 205, 206, 217, 258, 262.

263. Taiganides, E. P., Baumann, E. R., Johnson, H. P., and Hazen, T. E. ANAEROBIC DIGESTION OF HOG WASTES. J. Agr. Engin. Res. 8(4): 327-333. 1963.

The application of the anaerobic digestion process as a method of treatment of hog wastes was evaluated with laboratory-size digesters. Since digestion is not affected by the size of the digester, the results obtained were used to evaluate the design and to formulate the operational procedures of large field installations.

At 95° F., with once-a-day feeding and with continuous mixing of the contents of a single-stage digester, hog wastes were digested satisfactorily at a loading rate of 0 to 2 lb. of volatile solids per day per ft.³ of digester capacity and detention period of less than 10 days. On the basis of a daily volatile solids loading rate of 0 to 2 lb./ft.³ and 10-day detention period, the digester capacity required is approximately 1 ft.³ for every pig produced within a year.

The average gas yield per day per lb. of volatile solids added to the digesters ranged from 7.8 to 10.3 ft.³. Analysis of the gas showed a methane content of about 59 percent and a carbon dioxide content of 40 percent. The heating value of the gas was estimated to be 3600 B.t.u./day from the daily wastes of a pig.

The fertilizer value of manure as measured by its nitrogen content was increased through digestion. The digested manure was soupy, black, had no offensive odors, and flies were not attracted to it. The organic matter of the raw manure and, thus, its potential polluttional strength was reduced by 60 to 70 percent through digestion.

Considerations for the design of a digester were discussed. Although the initial investment for a digester is high, profit may be realized by operations producing over 10,000 hogs per year through the utilization of the excess combustible gas produced during digestion of the wastes.

Iowa State U., Ames, Iowa.

264. Ray, M. L., and Child, R. D. BROILER HOUSE LITTER USED AS ROUGHAGE IN FINISHING RATIONS FOR STEERS. Ark. Farm Res. 8(3): 2. 1964.

The depression in prices for finished cattle experienced by cattle feeders has accelerated the search for satisfactory low-cost feeds, particularly roughages.

A byproduct of the broiler industry was tested. Broiler house litter is available in many areas in large quantities and at a relatively low cost. Broiler house litter with a rice hull base was compared to a 12 percent protein-level rice hull roughage for finishing yearling steers.

The problem of obtaining maximum feed intake by animals has been associated with the dustiness of rice hulls and rice-hullbase chicken litter. In an attempt to alleviate this problem, 2.25 percent animal fat was added to both rations at the expense of corn and milo. The composition of the four rations fed was given in Table 1.

Table 1. Composition of Rations

Ingredient	B-1	B-2	B-3	B-4
	Pounds			
Ground corn	850	830	850	830
Ground milo	650	625	650	625
Fat	-	45	-	45
12% protein				
rice hulls	-	-	500	500
Broiler house				
litter	500	500	-	-
Total ¹	2000	2000	2000	2000

¹115 grams vitamin A concentrate (30,000 I.U. per gram) were added per ton of feed.

Four groups of 7 yearling steers were fed for 112 days completely mixed rations in which either chicken litter or rice hulls supplied the roughage portion. The grain to roughage ratio was 75:25. The steers weighed about 700 pounds and graded "Good" when the test began. All were wormed and implanted with Synoxes-S at the beginning of the study. Each steer was individually stall fed twice daily, being allowed access to feed for about 1 hour at each feeding. Water, salt, and dicalcium phosphate were available "free choice" in an exercise lot adjacent to the feeding barn. The results were given in Table 2.

Table 2. Results of Feeding Broiler Litter and Rice Hull Rations¹

Measure	B-1	B-2	B-3	B-4
No. of steers	7	7	7	7
Av. initial weight (lb.)	724	724	715	698
Av. final weight (lb.)	1,012	1,029	1,024	996
Av. gain (lb.)	288	305	309	298
Av. daily gain (lb.)	2.57	2.72	2.76	2.66
Feed per lb. gain (lb.)	8.17	8.20	7.97	7.48
Av. daily feed intake (lb.)	21.0	22.3	22.0	19.9
Feed cost per lb. gain (cents) ²	15.6	16.4	17.0	16.6
Av. initial grade	Good	Good	Good	Good
Carcass grades at end of trial				
Choice (no of steers)	0	2	3	2
Good (no. of steers)	5	5	3	5
Standard (no. of steers)	2	0	1	0

¹Ration B-1, broiler house litter; B-2, litter with fat; B-3, rice hulls; B-4, rice hulls with fat.

²Feed costs per ton were: B-1, \$38.39; B-2, \$40.22; B-3, \$42.68; and B-4, \$44.51. Broiler house litter was figured at \$9.00 per ton, 12% protein-level rice hulls at \$9.00 per ton, and prairie hay at \$30.00 per ton.

The data indicated that broiler house litter can be used satisfactorily as the roughage for finishing yearling steers providing a small quantity of long hay was fed to prevent bloat. Adding fat was of no value.

Agr. Expt. Sta., U. Ark., Fayetteville, Ark.

265. Jones, E. E., Jr. INTERMEDIATE STORAGE FOR FARMSTEAD WATER SYSTEMS. Md. Coop. Ext. Serv. Agr. Engin. Release No. 23, 23 pp. 1964.

The use of adequate intermediate storage will permit many farms to meet the desirable peak demand of the farmstead from low yielding ground water sources. In many areas, considerable savings in the first cost of developing a source of supply, selection of pumps, and water quality improvement equipment will be realized.

The labor saving potential of a reasonably adequate farmstead water system exceeds the cost of meeting the desirable peak demand of the farmstead when adequate intermediate storage is used. At the present cost of electricity, a 50 percent reduction in pumping costs means only a small annual reduction in the electric bill. Except where the minimum rate is determined by the farmstead electrical demand, the reduction in connected horsepower may be significant.

When the reduced operating costs were considered over the life of intermediate storage, the savings were a major factor in favor of the use of adequate intermediate storage.

A water system depending on intermediate storage should have two storage tanks for reliable uninterrupted service. There were many benefits of using overhead storage that justify the increased cost of the structure required to support the overhead storage tank.

The location of the water system center and the distribution system affects both first cost and operating costs. Distribution lines should be as short as possible. Take advantage of gravity to overcome pipe friction losses where possible.

Annual ownership costs of the distribution system may be minimized by careful selection of the materials used and by making ample allowance for future expansion.

The provisions included in this water system for farmstead fire protection increase the first cost of the system, but in most cases they also improve the reliability of the system or reduce operating costs.

The use of adequate intermediate storage eliminates many of the limitations of the conventional simple water system, improves the reliability of the water system, and reduces the cost of meeting the desirable peak demand of the water system as farmstead water use increases in the future.

Coop. Ext. Serv., U. Md., College Park, Md.

266. Blew, J. O., Jr., and Kulp, J. W. COMPARISON OF WOOD PRESERVATIVES IN MISSISSIPPI POST STUDY: 1964 PROGRESS REPORT. U.S. Forest Serv. Res. Note FPL-01, 15 pp. and tables. 1964.

Experimental untreated southern yellow pine posts installed from 1936-38 at the Harrison Experimental Forest, Saucier, Miss., had an average life of 3.3 years. Untreated longleaf pine posts installed in 1949 had an average life of 2.3 years, while those treated with a No. 2 fuel oil and with Wyoming residual petroleum oil had an estimated average life of 5 and 8 years, respectively. Of southern yellow pine posts installed from 1936-41, those treated with borax-boric acid have all failed with an average life of 10.6 years and those treated at the groundline and top with Osmoplastic have all failed after an average life of 11.2 years. Posts treated with the following preservatives and installed from 1936-41 have had failures totaling 10 percent or less of the number installed and should last 43 years or longer on an average: Pentachlorophenol, 4.8 percent in crankcase oil (crankcase oils may contain chlorinated naphthalenes, which are reported to be a contributing cause of "X-disease" (hyperkeratosis) in cattle. These oils are therefore not recommended to preservative treatment of wood with which cattle may come in contact.); copper sulfate and sodium arsenate applied by double diffusion; and zinc meta arsenite. Posts in test in 1936-41 treated with other preservatives had an estimated average life of 8 to 42 years.

Forest Products Lab., FS, USDA, Madison, Wis.

Radioactive Fallout

267. Hansen, W. G., Campbell, J. E., Fooks, J. H., Mitchell, H. C., and Eller, C. H. FARMING PRACTICES AND CONCENTRATIONS OF FISSION PRODUCTS IN MILK. Public Health Serv. P. 999-R-6, 44 pp. 1964.

Studies conducted over a 3-year period have shown that levels of strontium-90 and iodine-131 in milk can be moderated by optimal fertilization of the land. In controlled experiments, milk from cows grazing on abundant, well-fertilized pastures contained 50 percent or less of these radionuclides than did milk from cows grazing on

unfertilized pastures on the same farm. A mechanism of dilution of the fission-product contamination in the larger volume of faster growing fertilized forage was shown to account for the differences in the milk. The findings suggest one possible means of controlling fission-product contamination in milk, if such control measures should be necessary.

The results indicate that the high levels of strontium-90 in the St. Louis raw milk samples may have been due more to marginal fertilization of the farms than to uneven deposition of fallout.

U.S. Dept. Health, Ed., and Welfare, PHS, Div. Radiological Health, Washington, D.C., 20201

268. Eisenhower, C. AN ENGINEERING METHOD FOR CALCULATING PROTECTION AFFORDED BY STRUCTURES AGAINST FALLOUT RADIATION. U.S. Dept. Com., Natl. Bur. Standards NBS Monog. 76, 20 pp. \$0.20. 1964.

A discussion of the technical assumptions underlying the methods currently recommended by the Office of Civil Defense (OCD) for calculating protection afforded by structures against fallout radiation was given. Methods for calculating the contributions from radioactive sources on the roof and on the ground surrounding a simple one-storied building were discussed. How each technical chart in the OCD Professional Manual was derived from basic data on radiation penetration developed by Dr. L. V. Spencer was shown in detail. Charts from the Professional Manual and relevant curves from Spencer's work were included.

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